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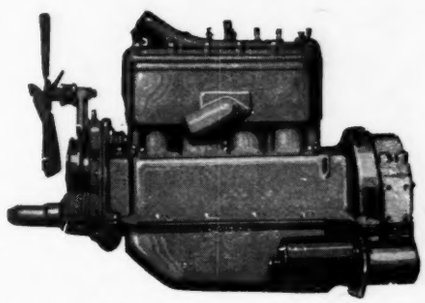

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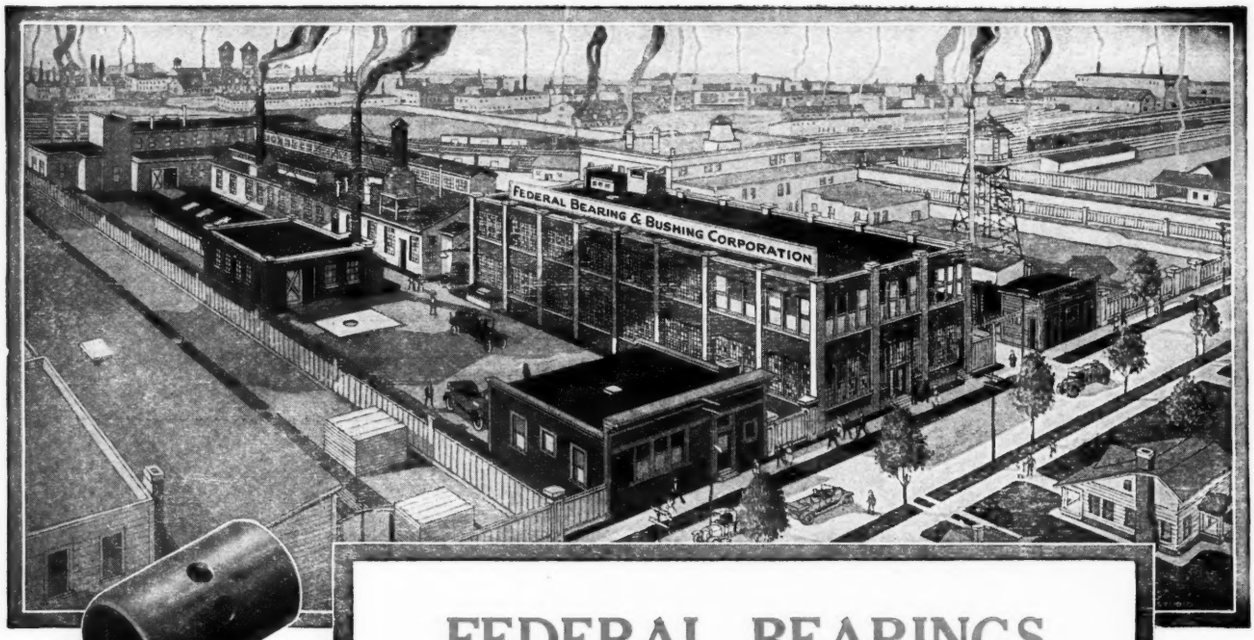

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AUTOMOTIVE INDUSTRIES
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Engineering Research Problems Discussed by S. A. E.

Fuel research session feature of annual winter meeting. Other research problems discussed. Motor bus development predicted. Engineers view their work from merchandising standpoint. Over 700 attend.

THE nineteenth annual meeting of the Society of Automotive Engineers, held in New York City, January 10 to 13, served to emphasize the importance of the part which the engineer is being called upon to play in the adjustment of the economic problems of the industry. Past-President David Beecroft, speaking at the annual banquet, sounded a fundamental note when he declared a firm belief in the future of the industry and when he stated emphatically, as regards the much-discussed saturation point, that "the saturation point for automobiles and trucks is the saturation point of transportation."

The emphasis on research in current engineering problems was a dominant feature of the meeting. Besides the session entirely devoted to research, there was considerable material of a similar nature running through many of the other sessions. Fuel research, in particular, received considerable attention which served to emphasize again the vital importance of such investigations. All of the sessions tended to promote the construction of better and more efficient motor vehicles.

A survey of all the sessions held during the four-day gathering indicates that the individual members of the organization and the society as a whole are already working along the lines indicated by President Bachman, when he said in his inaugural address, "We are entering a period during which the engineer must view his problems from the commercial as well as the technical side."

Viewed from the standpoint of constructive effort, the meeting was one of the most successful ever held by the society. Over 700 attended the technical sessions, while there were nearly 900 at the annual dinner. About 600 were present at the carnival, which can be briefly but adequately described in the words of the rural weekly, "A good time was had by all."

The chief feature of the technical sessions was the presence of Harry Ricardo, the distinguished British engineer, whose research work concerning the factors affecting combustion has attracted so much attention recently in engineering circles.

The winter meeting began with the meeting of the Standards Committee, at which a large majority of the recommendations previously submitted were adopted. At the general business session the following officers were formally declared elected:

President, B. B. Bachman; first vice-president, J. V. Whitbeck; second vice-presidents, F. E. Watts, H. E. Morton, O. W. Young, V. E. Clark and C. B. Segner; treasurer, C. B. Whittelsey; councilors, Lon R. Smith, C. F. Scott, H. M. Crane and W. R. Strickland.

The motor transportation session was well attended and developed some lively discussion.

The other technical sessions were as follows: Airplane engine, body engineering, fuel and engine research, lubrication, materials, and passenger car.

The annual dinner brought forth some interesting comments on the present engineering and economic status of the industry. Past-President Beecroft pointed out the necessity of looking forward rather than backward and emphasized the great privileges and possibilities for development offered to engineers of the present generation.

Particularly emphatic were the assertions of Charles F. Kettering, who served as toastmaster. He parodied the "Grasshopper" song, which was one of those chanted during the dinner, and suggested that the "r" should be eliminated so that a "gashopper" would remain. Then, after mentioning price cuts, he proposed the refrain:

"They are all playing poker.
They are all looking for the joker.
They are all going broker."

"The automotive engineer," said Kettering, "has got to quit looking at the past and face the future—and his company's creditors. Up to this time the engineering profession has been guided by a lot of people specially ordained not to listen to anyone but themselves. Advertising managers have made poor Ananias cry.

"The time has come for engineers to have ideas of their own and tell them to the management. They must tell what a good automobile really is if they, in their peculiar positions, really know.

"I wonder if we know where we are going? The automotive industry is just as predominant as the bread and butter industry. It is a great transportation activity. If everyone everywhere ever had a practical problem it is to find out what is the simplest thing he can do and what it will do. It is true of every industry that competition comes only when progress stops.

"It is up to engineers to set new standards of economic values. The only reason you've got a second-hand problem is because your new cars are no better than your second-hand ones. We're only three years away from the war, and for the Lord's sake blame it on that while you've got a chance."

President Bachman, in his inaugural address, made a striking statement of the fundamentals upon which rests the progress of the automotive industry. He pointed out the basic fact that the Society of Automotive Engineers has progressed because it has served. This, he said, is basic and fundamental. "The task must always mean more than the reward, if we are to succeed," said Bachman. He then stated his belief that there is a strong tendency to over-organization in modern industry, and his feeling that a simple program of service is the one to which the society can best apply itself during the coming year. He left with the members the watchword of service as the basis for the progress which is hoped for under his administration.

Arthur Richmond Marsh, editor of *The Economic World,* spoke on the topic, "How Shall We Know When Business Has Really Turned the Corner?" He outlined for his audience a few elementary economic principles and then showed their application to the present economic situation. He pointed out the fact that money is merely a medium of exchange and that, in the last analysis, only goods can be used to buy goods.

Perhaps the most interesting statement in Marsh's talk, from the standpoint of the immediate practical situation of the industry, was that "competition is always the keenest and conditions the most difficult in an industry when it is operating between 75 and 90 per cent of its total capacity." This is the present condition of the automotive industry. During such a time, Marsh said, every manufacturer is not only worried by the spectre of overhead costs, but is near enough to capacity to think that by price cutting or some other means he may be able to get into 100 per cent production, reduce his overhead and accomplish what his fellow manufacturers have been unable to do.

Not only did the general gatherings at the annual meeting bring out much constructive thought, but the technical sessions, as well, developed considerable interesting discussion. In certain instances, however, there was a noticeable lack of familiarity with the papers on the part of members attending the session, and as a result the discussion in some instances tended to be a rather scattered collection of thoughts on the general subject, rather than a close discussion of the points involved. The efforts of the society's permanent staff to get the papers in the hands of members well in advance of the meeting have done much to offset this difficulty, but further co-operation from the individual members is necessary if discussions are to attain their full measure of value for all concerned.

Research Session

By Herbert Chase

PROBABLY the best attended and in many respects the most important and interesting session of the Annual Meeting was that devoted to the paper entitled "Recent Research Work on the Internal Combustion Engine" by Harry R. Ricardo. This paper supplements earlier reports printed in these columns last year, and gives much new material regarding the progressive and timely work being done in England by this prominent British engineer who came to this country primarily to present this paper, which is printed on other pages of this issue. Mr. Ricardo was given a cordial reception by the members of the Society and was complimented by the chairman, Henry M. Crane, and by many other members for the excellent paper he had prepared. The author was particularly commended for his willingness to permit others to benefit by the results of his research work before this has been completed, especially since in so doing he faces the possibility of having, as a result of later experience, to change views or conclusions reached in the paper. Mr. Ricardo frankly admitted, in fact, that his recent work had revealed facts which made it necessary to alter some previously published views especially regarding the effect of turbulence upon detonation.

In opening the discussion Chairman Crane mentioned the fact that most of the work covered by Mr. Ricardo's paper had been done on a single-cylinder engine, thus avoiding many of the difficulties involved in securing proper distribution, which must be faced by those designing multi-cylinder engines.

C. P. Grimes mentioned recent tests, which he has conducted in which he found that economy was increased by increasing the temperature of the cylinder wall. He also mentioned tests made in this country several years ago in which kerosene had been used successfully in an auto-

mobile engine in which the charge had been diluted by the addition of exhaust gas. This dilution had, however, resulted in considerable decrease in power, which accounted for lack of interest in developments of this character.

Prof. Wilson took exception to the impression conveyed by Mr. Ricardo's paper to the effect that pressure has a relatively small bearing upon combustion phenomena. He stated that the rate of reaction in the case of gases increases approximately as the cube of pressure.

Thomas Midgley, Jr., criticised some of the conclusions reached as not being fully substantiated by the data given. He said he was unable to see how the experiments on the adiabatic compression machine could be considered as comparable to engine conditions, in view of the fact that ignition was spontaneous and not by electrical means as in internal combustion engines. He recalled Prof. Dixon's work in which photographs of the flame were taken and mentioned the value of tests made in such a way as to enable the observer to actually see and photograph the combustion phenomena.

E. R. Hewitt mentioned tests he had made by dropping a bomb filled with a combustible mixture into molten lead heated to various temperatures. In some cases he found that complete combustion occurred without a rise in pressure, the combustion having proceeded at such a slow rate that the heat was dissipated as rapidly as it was liberated.

Harry R. Ricardo

O. C. Berry criticised the British practice of giving results in terms of indicated horsepower, in view of the difficulty of making accurate measurements of this power, but said that he realized certain advantages from the theoretical standpoint if the measurements were sufficiently precise. He said he favored measurement based on b.hp. due to the certainty with which brake power can be determined. R. W. A. Brewer asked whether any of the author's experiments had been conducted with gasolines of the grade used in this country, and L. H. Pomeroy mentioned the frequently noticed effect of carbon deposits upon detonation.

G. A. Green outlined some exhaustive tests made by the Fifth Avenue Coach Co. on the Ricardo slipper-type aluminum piston. These, he said had resulted in considerably less wear, higher mechanical efficiency, lower oil consumption, less carbon deposit and slightly higher economy.

Herbert Chase mentioned the fact that the degree of spark advance had been found in tests made by the Bureau of Standards to have a marked effect upon detonation, and asked whether this factor had been given due consideration in Mr. Ricardo's work. He asked also regarding the means used to determine when detonation took place. He commented favorably upon the work with constant compression stratified charge engines conducted by Mr. Ricardo and stated that he hoped that a number of individuals who have been experimenting recently with this type in this country would be willing to give out data on their work similar to that which Mr. Ricardo has given.

In replying to the discussion Ricardo stated that in his belief the matter of pressure as affecting detonation is important, but that chemists with whom he is collaborating held other views in this regard. He said that he is quite familiar with the experiments conducted by Prof. Dixon on compression and flame movement, but that these experiments had been made without sufficient regard to the effect of cooling losses, a factor which had been given careful consideration in experiments reported in the paper. Regarding the use of i. hp. instead of b. hp. readings, he stated that while the i. hp. readings were not perhaps absolutely correct, they were sufficiently close for comparative purposes. Furthermore they eliminate the friction element which varies with each engine, and therefore render results more nearly comparable.

In the tests made with exhaust gas used as a diluent, the precise amount of exhaust gas used was not measured, but an estimate of the amount used can be had by comparing the m.e.p. figures given, said the author. The distinctive sound or pinking which accompanies detonation was, he said, the means of determining when detonation took place. The author said that he fully recognized the fact that carbon deposits have a material effect upon detonation, and that great care was used to control this factor. In the case of the adiabatic compression machine the combustion chamber was always cleaned after a detonation in which carbon is deposited had occurred, as it was found that unless this was done succeeding tests were erratic.

In concluding his remarks Ricardo stated that he is still enthusiastic regarding the possibilities of the stratified charge type of engine but regards the Diesel engine, for automotive applications, as being very far in the future.

The session was concluded by a rising vote of thanks to the author for his most excellent and stimulating paper

Fuel and Engine Session

By Herbert Chase

THE fuel and engine session was devoted to the presentation and discussion of three papers relating to fuel and the study of combustion phenomena. The first of these was entitled "Manifold Vaporization and Exhaust Gas Temperature" by O. C. Berry and C. S. Kegerreis. In this the authors gave it as their view that the most promising method of handling present-day fuels is by heating the charge or the fuel contained in the charge. Various methods for doing this are discussed and data obtained in experiments made at Purdue University with a view to determining the best temperature for the hot spot are given. The authors conclude that with properly designed manifolds and carbureters fuels considerably heavier than those now in common use can be used if necessary without seriously affecting the power or operation of present-day engines.

Aside from a very excellent discussion prepared by P. S. Tice, but presented only in part, the discussion consisted chiefly of asking questions regarding methods followed in the test. Mr. Berry stated that a spark advance of 31 deg. was carried throughout all tests, and that the temperature measurements were made close to the exhaust valve of one cylinder, the thermocouple employed being so insulated as to prevent false readings which might

result from direct heat conduction to adjacent metal parts.

The paper by Thomas Midgley, Jr., and T. A. Boyd entitled "Methods of Measuring Detonation in Engines" was devoted to a description of four methods which have been employed in work done in the testing laboratories in the General Motors Research Corp.

The listing method, he said, is erratic due to the personal factor of the observer. The indicator method is better because a positive record is obtained. The use of a thermocouple and galvanometer is not suited to accurate work because of a number of variable conditions which it is difficult to segregate and control. The bouncing pin method which has been developed to give a cumulative measurement is quite fully described and possesses certain advantages not secured by other methods.

There was but little discussion of this paper or the paper by Thomas Midgley, Jr., and W. K. Gilkey, entitled "Spectroscopic Investigation of Internal Combustion" which followed, these being more of an educational nature than intended to create discussion. The last mentioned paper described the apparatus and some results obtained by careful work conducted by the authors. It appeared from the paper and such discussion as followed it that investigations of this character present many difficulties, and the results are difficult to evaluate, although they may ultimately result in securing many valuable facts.

Lubrication Session

By P. M. Heldt

THREE papers dealing with topics relating to lubrication were presented at a session held on Wednesday afternoon. Winslow H. Herschel, associate physicist of the Bureau of Standards, presented a paper on Viscosity and Friction. Mr. Herschel said that:

"The study of lubrication is made more difficult by the fact that there are different regimes in which different properties of the lubricant have the controlling influence. At the highest speeds and lowest pressures the friction is nearly constant under widely varying conditions. At lower speeds the viscosity of the lubricant and the kind of material constituting the rubbing surfaces have a marked effect; and at the lowest speeds and highest pressures another property of the lubricant, which can be called oiliness, has the predominant influence. Frequently, only two regimes are considered; that of complete film lubrication where the viscosity has the greatest effect, and that of incomplete film lubrication where the oiliness becomes of major importance. The transition point, where the friction is at a minimum, comes within the former regime. The influence of bearing metals is evident with incomplete film lubrication, and in the greater part of the regime of complete film lubrication.

"In selecting a lubricant the properties that need to be considered can be divided into two classes; properties indicating that it is suitable for the purpose at hand, and those giving assurance that it will be reasonably lasting in use. It is not the purpose of this paper to consider the question of the deterioration of oils, but merely the above-mentioned properties of new oils that indicate suitability at least for short-time use. If all the changes of the lubricant with time, by evaporation, oxidation or otherwise are disregarded, the only remaining properties that determine the friction are viscosity and oiliness."

In the paper the relation of absolute viscosity to the readings of the instruments ordinarily used, the estimation of the viscosity at one temperature from the viscosity measured at another temperature, friction tests of bearing metals, incomplete film lubrication, the oiliness of lubricating oils, service tests, and desirable features of oil friction testing machines were discussed and the following conclusions were arrived at:

(1) In comparing viscosity and friction it is necessary to use a unit of absolute viscosity, preferably the poise or centimeter-gram-second unit
(2) The viscosity in poises can be calculated from times of flow in seconds by suitable equations that are given for the viscosimeters most frequently used
(3) In estimating the change of viscosity with the temperature, it is convenient to make use of the observed fact that, with certain restrictions, the logarithmic viscosity-temperature graphs are straight lines which meet at a point
(4) Friction tests with complete film lubrication can give no information in regard to the quality of a lubricant, and viscosity is measured more readily with a viscosimeter
(5) The only use of a friction-testing machine for determining quality of a lubricant is in measuring oiliness, and this must be done at high pressures, low speeds or other conditions which cause incomplete film lubrication. It can be assumed that the pressure must be over 800 lb. per sq. in. (56.2 kg. per sq. cm.) or the speed less than 40 ft. per min. (0.20 meters per sec.)
(6) Bearing metals also should be tested with incomplete film lubrication
(7) It is impracticable to keep a constant smoothness of rubbing surfaces with a journal bearing, so that changes in friction, commonly supposed to be due to changes in quality of lubricant, are generally due to changes in smoothness
(8) Service tests are even more untrustworthy than friction tests, because there are a multitude of bearings whose temperature cannot be controlled or estimated readily
(9) The best solution of the difficulty appears to be the use of a disc machine. The disc could be kept of constant smoothness by removing an interchangeable veneer and subjecting it to a standardized polishing process after the test of each oil, if necessary. A journal could not be kept polished in this way because the radius of curvature, and consequently the film thickness, would be changed.

In the discussion of this paper the subject of temperature of oil film on cylinder walls was referred to, and one member said that some years ago he had had occasion to determine the temperature of the film in an Hispano-Suiza aircraft engine. This engine had a threaded steel liner screwed into an aluminum cylinder casting, and as it was impossible to get an absolute fit of one threaded portion in another, the heat had to flow through an air gap as it were, which necessarily retarded its flow to the water jacket. It was found that in this engine the oil film temperature was about 220 deg., and in ordinary engines it would be less. The reason given to explain this low temperature of the film was that a film of dead gas existed on the inside of the oil film which protected the oil film, keeping down its temperature.

The question was raised whether there was any connection between the viscosity, the piston clearance and the

piston friction. Mr. Herschel explained that the resistance was inversely proportional to the thickness of the lubricating film. There seemed to be a great deal of haziness in the minds of the audience as to what constituted oiliness. The author explained this by saying that lard oil is known to be a good cutting oil, while mineral oil is less efficient for this purpose. Cutting oils act under very intense pressures. It is possible to have mineral oil and lard oil of the same viscosity and the difference in the action of the two oils is then due to differences in oiliness.

Tension and Friction

The surface tension of all oils is practically the same, but the friction of an oil-lubricated bearing depends upon the interfacial tension and not upon the surface tension. The Bureau of Standards is now investigating the effect of organic acidity on the interfacial tension and hence on the oiliness. It was brought out in the discussion that information on oil films is very meager. The journal is not concentric with the bearing except at very high speeds, and for lower speeds the thickness of the film varies, being least at the line of minimum pressure.

It was stated that Professor Carpenter had found that the bearing metal showing the least friction wore away most rapidly. In this connection Mr. Herschel pointed out that the rate of wear of bearing metals was merely a function of the perfection of fitting.

It was also brought out that oiliness is dependent upon the proportion of the unsaturated constituents in the oil. With an excess of unsaturated compounds there is a tendency to gumming; enough saturated compounds are wanted to give good oiliness, but not enough to cause gumming. According to a report by the Lubricants and Lubrication Inquiry Committee in England it is the unsaturated compounds which are the most valuable constituents of lubricating oil.

Mr. Chilton said that he had made some tests of oil derived from shale oil and it had been found that this was a better lubricant than oil from crude petroleum.

Fluid Friction and Transmission Efficiency

A paper on the Relation between Fluid Friction and Transmission Efficiency was read by Neil MacCoull. In this paper the author, who is connected with the Texas Co., gave an account of some tests made to determine the friction losses in automobile transmissions under different conditions of load, speed, viscosity and quantity of lubricant. The method used for making these tests is of interest. Two four-speed truck transmissions were coupled together with their rear ends and the two cases were joined together by means of stays and supported freely upon the driving shafts, so that they had a tendency to turn around this shaft. The couple with which they tended to turn was measured by providing the cases with a torque arm to which a balancing weight could be applied. This torque, together with the speed of the shafts, gave the power loss in the transmission. The power transmitted was measured directly by a dynamometer to which the transmission farthest from the power source was connected.

It was found that the torque loss was greater the lower the temperature of the oil in the transmission, as would be expected. The no-load loss, for instance, was about five times as great when the oil was at 40 deg. Fahr. as when it was at 120 deg. Fahr. When the transmission was under load the variation of the loss with the oil temperature was materially less. Different oils gave widely different no-load losses at low temperatures, while at temperatures exceeding 150 deg. Fahr. the losses approached very closely to each other.

This series of tests has been begun only recently and is far from completed. No conclusions were drawn, and it is expected that further results will be presented at a later meeting of the Society.

In the introduction to his paper Mr. MacCoull gave an analysis of the power losses due to different causes in automobile propulsion, including the losses due to wind, tires, wheel bearings, rear axle gearing, transmission, engine friction losses and engine pumping losses. It was pointed out that there was very little experimental data available on the losses due to the air resistance at different speeds, and in the discussion of this paper one member stated that tests to determine the air resistance of vehicles were to be made at the Kansas Experiment Station. This Station has constructed a concrete pond on which is to be placed a raft of sufficient size to carry the car on which measurements are to be made. In Kansas there are strong and steady winds during certain seasons of the year; the raft with the car upon it will be oriented so the radiator will point directly into the wind, and the drifting force due to the car will then be measured and compared with the strength or velocity of the wind.

Reference was also made to tests made on Class B trucks on a chassis dynamometer during November. It was found that the reduction of loss due to the heating of the oil was much less in a machine that had had considerable use than in a new machine. It was also found that most of the reduction in frictional loss resulted from the first 10 to 15 deg. temperature rise.

The Mechanism of Lubrication

Robert Wilson and W. P. Barnard 4th presented a paper on The Mechanism of Lubrication. They discussed the general theory of "greasy" and fluid friction, partial and complete lubrication and pointed out that all the customary quantitative tests and specifications for oils are designed mainly to meet conditions of fluid friction where the motion of the bearing carries and maintains a film of liquid between the metal surfaces. For this purpose, the general rule to use the oil of the lowest viscosity that will maintain the fluid film is probably sound. The authors pointed out, however, that while a properly designed bearing might be working under conditions of fluid friction the greater portion of the time, the real advantage of an oil over other fluids did not appear at all under these conditions, as evidenced by the fact that bearings running continuously at reasonably high speeds and low loads could be lubricated with entire satisfaction by glycerine solutions or kerosene, or even by air under certain extreme conditions.

On the other hand, it is indisputable, the authors stated, that neither glycerine solutions nor kerosene are satisfactory lubricants for metals under actual operating conditions. To show up their deficiencies, however, it is necessary to note their behavior under conditions of slow speed or heavy load, as when starting or stopping. Under such conditions of *partial* lubrication the presence of water, glycerine or even kerosene gives friction coefficients nearly as high as for the dry metal surfaces, and seizure or serious abrasion is likely to result, with consequent excessive friction and overheating after the bearing has run for a short time. Under these conditions lubricating oils give much lower friction coefficients, with little tendency for the surfaces to seize or abrade. This behavior is frequently referred to as the property of "oiliness."

To study some of these fundamental aspects of the mechanism of lubrication, the research laboratory of applied chemistry at Massachusetts Institute of Technology has undertaken an extensive research program with the financial support of the General Motors Research Corporation. Certain new methods of studying lubricating

films have been developed and are described in detail, together with a discussion of the preliminary results obtained therewith, which in general appear to support the above-mentioned hypothesis of a plastic solid film composed, it is thought, mainly of certain colloidal constituents in the oil.

Professor Wilson, who presented the paper, said that there were at least six reasons why a study should be made of the property of oiliness. He also emphasized the enormous range in the coefficient of friction, which varies from about 0.3 for dry or unlubricated bearings to 0.00075 for well lubricated bearings operating under the most favorable conditions. By means of lantern slides it was shown that as a bearing is started up, the friction drops very rapidly from the high value for static conditions which is due to the existence of metallic contact when the journal is at rest. A minimum value of the friction is reached at a certain speed, and beyond that speed the friction increases again. It would evidently be best to operate at the speed corresponding to minimum friction, but designers are afraid of the nearness of the regime of high speed, high friction, and operate at a much lower speed, where the friction is higher.

A small amount of some fatty acid in oil makes a big difference in the oiliness. There is something in oil, Professor Wilson said, that builds up the lubricating film by absorption, and he hoped to soon have enough of this constituent to find out what it was. There are a number of commercial oils on the market in which advantage is claimed to have been taken of this property of organic acids to increase the oiliness. Heating mineral oils with sulphur compounds increases the static friction.

Motor Truck Transportation Session

By Floyd E. Williamson

MOTOR bus development and the various phases of truck operation came in for a good share of discussion at the Truck Transportation session of the S.A.E. held Wednesday afternoon. Walter Jackson presented a paper on the Past, Present and Future of the Motor Bus, and Economics of Motor Transport was the subject of a paper by Merrill C. Horine, Engineer, International Motor Company.

Jackson declared that in his opinion street railway companies were the logical operators of motor buses. He decried the use of jitneys and individually operated cars, for in many instances he said they were run upon an uneconomical and irresponsible basis. Street railway companies, however, can operate buses to immense advantage in instances in which additional trolley equipment would otherwise have to be provided. Company ownership would secure a higher class of service and more efficient operation. It was pointed out that in cities having a well defined electric railway transportation system there was small chance of the motor bus destroying that system or even crippling it, but in such cities there is an excellent opportunity to conduct bus lines as subsidiaries to the electric railway, providing fares can be adjusted according to the class of service rendered.

In the discussion of this subject comparative costs of operation and installation formed the basis for considerable argument. So far as the latter item is concerned there was, of course, no dissension of opinion, for the motor bus in that respect has a decided advantage. Figures were presented to show that it costs between $6,000 and $10,000 to install a mile of trolley overhead equipment above in addition to the cost of the rolling stock which was shown to be higher than the cost of motor buses. Operation costs, however, in the opinion of many who entered into the discussion, are to the advantage of the electric railway in some instances, especially those in which the cars can be run full, standing room included. Others contended that with proper attention a motor bus would prove as economical, if not more economical than the trolley, size for size. Those who held to this opinion, however, admitted that the density of traffic would play an important part in determining this point. So far as upkeep is concerned the general opinion seemed to prevail that there should be little difference in the maintenance of motor buses and the rolling stock of a trolley company.

Concerning the trackless trolley as a competitor of the motor bus, it was agreed that these lines have not the flexibility of the motor bus, which, by the way, was shown to be one of the chief advantages of the latter vehicle over any other means of transportation. G. A. Green said that trackless trolleys are heavier, more complicated and probably more expensive than motor buses.

Another great advantage of the motor bus also lies in the fact that it can materially aid in speeding up traffic now congested by street car operation. It is no uncommon sight to see a trolley car stopped at a street crossing to allow passengers to alight or get aboard and thus delay 20 or 30 vehicles which are forced to wait until the passengers have safely reached the sidewalk. Were the minutes lost throughout the country in this manner totalled up they would reach an enormous number of hours lost each day. Use of bus transportation, naturally eliminates this delay for passengers are taken to the edge of the curb and other vehicles proceed upon their way undisturbed. In discussing bus design the question was raised as to whether or not an ordinary truck chassis is suitable for a bus body. Opinions expressed on this subject were decidedly in favor of a specially designed chassis. The motor bus is a carrier of human freight, and this class of freight demands a definite amount of space. About seven ft. is the width required for comfort and economy and this is about 14 in. wider than the dimension adopted by most truck manufacturers. The frame of a standard truck is also about 30 to 40 in. from the ground and this requires from three to four steps for passengers to enter and leave. In order to secure the maximum of efficiency and satisfaction in bus transportation the general opinion prevailed that special chassis should be employed.

Economics of Motor Transport

Horine's paper and the discussion following its presentation was centered, to a great extent, around the relation of the motor truck to the highways.

"The highway," said the paper, "which until the development of the railroad was the chief factor in the economic and military progress of nations, is once more taking its place as the most important factor in transportation."

It is for this reason that automotive engineers must turn their attention to highway development. Legislation that practically drives the heavy truck from the highways has been enacted in many states. Such legislation, on the surface, may appear to be the result of sound reasoning, but flimsy highways will not stand the wear and tear that is bound to result if heavy trucks are used upon them. On the other hand, heavy trucks, Horine contended, offer a

more economical means of transportation than do those of lighter weight and not only the truck operator, or shipper, benefits from their use, but the general public as well. Reduced transportation costs mean reduced costs of goods to the consumer.

The highway built to carry only vehicles of small load capacity, said Horine, will be put to a harder test and will be compelled to bear more weight than will the one designed to carry heavy vehicles. There is a certain amount of freight which must be hauled over the highways. The combined weight of several small vehicles is greater than the weight of one large one. The operation costs are considerably higher for a fleet of small trucks than for a single large one. Roads built to carry heavy trucks need not be built as wide as those for the lighter vehicles, since there will not be the density of traffic.

These points and many others were brought out to show that the elimination of the heavy truck is unsound from an economic standpoint, and to show that automotive engineers must carry their research work farther than to the truck itself and concern themselves with the surface upon which it is to travel.

The question of road building was discussed pro and con by several speakers, one who voiced the opinion of most of those present when he said, "Build foundations and you'll have roads; drain them and they'll stay."

Truck design was also taken up by several in the discussion and it was predicted by one speaker that a few years hence pneumatic tires would be used upon all motor vehicles. W. P. Kennedy made a plea for better spring suspension and suggested that there are now too many sizes of trucks produced for maximum economy in manufacture.

Francis W. Davis commented favorably upon the Connecticut law which limits the weight carried to the rated capacity of the truck and per inch width of tire, saying that such legislation, at first considered radical and detrimental, may after all prove a boon to the industry.

Passenger Car Session

By P. M. Heldt

THE session on Friday morning was inaugurated by the presentation of a paper on passenger car brakes by J. Edward Schipper. Mr. Schipper pointed out that during the past ten years great efforts had been spent on endeavors to increase the acceleration of cars, because the quality of a quick "get-away" made a car not only more enjoyable but also safer to handle in traffic. On the other hand, the problem of quick deceleration, which was just as important, had been more or less neglected. In testing out experimental cars, test drivers are often instructed to try and break the car up in driving over rough roads, the engineer feeling pretty safe that he will not succeed, but no instructions are ever given to descend long hills and try to burn out the brakes, because it is only too well known that the tester would succeed. The best brakes now carried on American cars are inadequate for service in mountainous districts, although they serve satisfactorily in flat and moderately hilly country.

In stopping a car the brakes convert the kinetic energy of the car into heat energy and radiate the heat to the atmosphere. Many of the present brake systems are absolutely incapable of disposing of the heat as fast as it is generated without reaching an excessive temperature if the descent is of considerable length. The steeper the grade, the more quickly the brake temperature will reach the danger point. Many of the hills encountered in the Allegheny Mountains, for instance, are so long that the lining materials will reach a temperature sufficient to burn them.

Mr. Schipper in his paper discussed the factors of design, means for securing uniform and effective braking power, exposed and protected types of brakes, brake actuating means, formula for brake drum size, car stopping ability, brake equalizers, brake linings, brakes of the future, the engine as a brake, four-wheel and front-wheel brakes, the servo principle of operation, miscellaneous braking methods and truck brakes.

H. W. Alden, who presided at the session, in throwing the paper open for discussion, said that as the time was limited, it would probably be best to confine the discussion to the use of the engine as a brake, the transmission brakes compared to two pairs of brakes on the rear wheels, and four-wheel brakes.

H. W. Slauson referred to trouble with breakage of brake shoe anchorages. Mr. McCulla said that in fuel economy contests it was the practice to use an overrunning clutch in the transmission, to bring the car up to speed and then let it coast. The objection to the use of the engine as a brake was the effect this practice had on the fuel consumption. Even though the throttle was nearly closed while the engine acted as a brake, a considerable amount of fuel was still being pumped through the cylinders, unless the expedient of providing the carbureter with an air valve opening the engine cylinders to the atmosphere was resorted to. In England a carbureter was being marketed which possessed this feature.

One member said that a car which he had driven thousands of miles was provided with a transmission brake and that he was very much pleased with its service. He had never had any skidding with this brake. The brake also required less effort to apply than a rear-wheel brake. Another member expressed the view that, if the transmission brake could be made with sufficient heat radiating capacity to dispose of the heat generated, it was the brake to use.

H. M. Crane said that for smooth action of any kind low unit pressures were required, but low unit pressures involved high surface speeds. In American cars the rotary speed of transmission brakes was anywhere from 3½ to 5 times as high as that of the rear-wheel brakes. Uniform distribution of pressure over the whole brake surface was equally necessary, and that was where the shoe type of brake fell down. We had only 4 or 5 in. pedal motion available, and if a considerable portion of this pedal motion were required for taking up lost motion, there must necessarily be a loss in brake power. With the brake of his design, which was described and illustrated in the paper, it was possible to slide the wheels of a 5500-lb. car with less than 50 lb. pressure on the brake pedal. The car had a rear-axle ratio of 4 to 1, and this, together with the use of a large diameter brake drum, made for a high surface speed in the brake.

To design brakes so that they alone would be adequate for controlling the speed of large cars in mountainous country was practically impossible. The engine was an ideal brake. In serving as a brake it acted substantially as an air compressor, the kinetic energy of the car being

expended in compressing and heating the air. The engine was thoroughly lubricated and it was also efficiently cooled. With small cars it might be possible to make the brakes sufficiently powerful to serve satisfactorily in mountain districts without recourse to the engine. One advantage of the transmission brake was that there was much less lost motion in the brake connections, as there was only a single set of linkages, instead of two. Mr. Crane said that he did not believe in four-wheel brakes; that he considered them to be less safe than the ordinary braking system.

Four-Wheel Brakes

Fred Duesenberg, as a user of four-wheel brakes, was called upon to say something on the subject. He said that, when driving a car equipped with rear-wheel brakes only in the Uniontown race, he burned out both sets of brakes and had to resort to the use of the engine. He had then adopted four-wheel brakes. In connection with these he used drop-forged brake drums with cooling flanges turned upon them, which, of course, made a rather expensive construction, but the cooling surface had been increased from 10 to 12 times, and after the descent of a long hill the drums were still sufficiently cool so one could put his hands upon them.

It had been held recently that there should be some difference in the effectiveness of the front and rear brakes, that the rear brakes should be stronger. They had put heavier springs on the front brakes so that the rear brakes took hold first, and this had given them excellent service. The hydraulic operation of the brakes, to which reference had been made, did away with a lot of parts and it gave perfect equalization without the use of any special equalizing gear. (The objection raised to the hydraulic brake gear was that if there was a break in any part of the system all of the brakes became ineffective. Of course, an emergency brake in the form of a transmission brake is generally provided for such eventualities.)

The second paper of the session was on Developing a Method for Testing Brake Linings, by S. von Ammon, associate mechanical engineer of the Bureau of Standards. The investigation of brake lining materials by the Bureau of Standards was undertaken as a result of the general policy of the Motor Transport Corps to standardize the requirements for materials and supplies for automotive vehicles for army service. Many tests of brake lining materials had been made in the engineering laboratories of the Motor Transport Corps in 1917 and 1918. At that time, however, it was not possible to devote much study to the determination of the most satisfactory conditions for a laboratory test. The conditions under which manufacturers of brake lining materials had tested their products and under which acceptance tests were made by car builders were so varied that results were not comparable and had yielded but little information. This lack of definite information and a recognized method of test made it necessary to develop a standard test for determining the relative merits of brake linings which could be used as a basis for specifications. In December, 1919, a subdivision of the Truck Division of the Standards Committee formulated a tentative program for developing a standard method for testing brake linings and invited brake lining manufacturers to have engineering representatives attend a conference at the Bureau of Standards on Dec. 18, 1919, to discuss the proposed program. The equipment designed jointly by the Motor Transport Corps and the Bureau of Standards, and built by the former, was completed so that preliminary tests could be begun in August, 1920.

The various features which it was thought required investigation are shown in the following abbreviated form of the original program. Its main divisions are considered as (*a*) fundamental and (*b*) supplementary. Under (*a*) the coefficient of friction is investigated in relation to

(1) Dry lining.
(2) Influence of water, oil, temperature and wear.
(3) Constancy of the coefficient.

Durability also is studied under (*a*), it having been decided to adopt the following:

(1) A standard rate of energy input, with consideration of established practice and limited to engine power.
(2) A drum of standard material and surface, and 12 to 16 in. in diameter, at a speed of about 1200 r.p.m.
(3) Stock sizes of linings; preferably the actual size considered.
(4) A policy of wearing linings down to about one-half of their original thickness.
(5) A long-time endurance test with the temperature kept constant by cooling water.
(6) A severe service test, the temperature of the drum being allowed to rise to equilibrium with constant power absorption.

The supplementary division includes

(1) Rivet-holding ability.
(2) Sticking after cooling on a hot drum of both new and worn linings.
(3) Change of thickness due to the absorption of water and oil.

The general considerations are inclusive of the

(1) Use of flexible-band shoes for supporting linings.
(2) Adoption of a standard method of riveting samples to shoes.
(3) The determination of the proportion and quality of asbestos and other materials used is not considered necessary, nor is a test for volatile matter thought important.

In the paper the apparatus used for the tests was described and various test results were given. In some of the tests water-cooled drums are used to prevent the brake lining from attaining such a temperature that the resinous material in it melts. The coefficient of friction of brake linings was found to range between 0.25 and 0.75 for water-cooled drums, and between 0.11 and 0.75 for uncooled drums. The majority of the averages for complete runs were between 0.35 and 0.45 for water-cooled drums and between 0.45 and 0.50 for uncooled drums. Tests were also made to show the influence of water and oil on the drum on the brake power and the results plotted, the curves being included in the paper. The tests also covered relative durability and rivet-holding ability. It was found that the latter is not a very important factor, as there is no trouble whatever from rivet holes tearing out. The author summarized his conclusions as follows:

The work done thus far permits the conclusion that the equipment and general methods developed are satisfactory for laboratory tests to ascertain the relative merits of fabric brake linings. To establish a suitable test for determining the relative behavior of brake linings under the more ordinary service conditions, where the application of brakes is intermittent and the resultant temperatures are comparatively low, further work is necessary. The severe service test as used with an uncooled drum is, however, believed to give a fair comparison of the behavior of linings when subjected to severe service. The results obtained indicate very low values of the coefficient of friction as a result of the action of heat on the impregnating compounds.

Very wide differences in the comparative endurance of linings now in use are indicated by the tests, as well as the possibility of marked improvement in durability under severe service conditions. Owing largely to the user's inability to obtain reliable information of the relative merits of linings otherwise than by prolonged use in actual service, purchases are made almost exclusively on the basis of first cost and without adequate consideration of quality or economy in operation. The general adoption of standard tests, such as have been described, will assist the producer materially in the systematic improvement of his product.

The better understanding by the user of the relative merits of brake linings, which can be brought about in the same way, will cause an increased demand for the better materials, those giving the most reliable and most economical braking service. The manufacturer will be spared the indignity of having to market materials on the basis of first cost alone, while aware that a relatively slight increase in first cost would permit him to offer materials that will give the user from 50 to 200 per cent more value in braking service.

The final paper of the session was on Photographic Recording of Engine Data, by A. Trowbridge, professor of physics at Princeton University. Professor Trowbridge during the war developed an automatic high-speed camera which he considers to possess great merits for the purpose of recording the motions of high-speed apparatus. The sensitized paper is automatically developed and fixed before it leaves the camera, and a simple mechanism allows the record to be taken at one speed and the paper to be developed at another speed. The author suggested the use of this camera for taking engine diagrams, especially at high speed.

It is possible to study variations which occur in time intervals as short as 0.001 sec. It is more convenient to transmit electrically to the camera the motion that actually takes place in the mechanism than to attempt to set up the camera itself close to the mechanism. It was found that a special form of simple string galvanometer is very convenient and meets satisfactorily the necessary condition that its moving part shall move synchronously with the motion of the mechanism. The moving part of the galvanometer is practically weightless, as it is a short piece of wire 0.004 in. in diameter, and its motion is strongly damped by the magnetic field in which it is placed. When a current is sent through this wire it moves in the magnetic field and a shadow of this motion is photographed by the automatic camera.

In practice almost any slight motion can be converted into a flow of electricity, so that the applications of photographic recording to the study of vibrations in running machinery are very numerous.

If it is desired to study the pressure changes in the cylinder of a running engine, a capsule with a stiff diaphragm can be screwed into a pet-cock opening and the motion of the diaphragm recorded as the motion of the string of the galvanometer. On any one record it is possible to secure a great many successive explosions and so compare them and draw conclusions as to the constancy of performance under supposedly constant conditions. The timing of the valves or the spark can be determined *dynamically* with an accuracy of about 0.0005 sec. This means in the case of an engine running at 2000 r.p.m. about 6 deg. of crankshaft travel. Thus the lag between the static and the dynamic timing can be determined at various engine speeds.

In a cylinder diagram obtained by means of this apparatus the cylinder pressure is plotted against the time, instead of against piston position. This is claimed to be a great advantage, as practically all the important changes in the cylinder occur near the ends of the stroke, when in the ordinary diagram the time scale is very small. By using the time for the horizontal scale, changes occurring near the ends of the stroke could be studied on the diagram with much greater accuracy.

There was very little discussion on the last two papers presented.

Body Engineering Session

By J. Edward Schipper

A VARIED program covering a field of wide interest in body engineering practice was offered at the session devoted to this subject. Papers were presented on body seating dimensions, California tops, harmony in car upholstery and the manufacture and application of automobile varnishes and paints. All of these were discussed from a number of different standpoints resulting in one of the most valuable sessions of the Winter Meeting.

George E. Goddard presented the paper on Body Seating Dimensions. In this paper the dimensions of automobile body seats received consideration with regard to the features that are conducive to comfort. A diagram was presented upon which the dimensions treated were indicated, and a tabulation of seat dimensions of 12 representative cars was included.

Comments were made upon the factors influencing seat dimensions, as well as recommendations regarding the different desirable dimensions. The considerations were inclusive of cushion height, depth and slope, leg-room and head-room, upholstery shape and softness of trimming, foot-rest and other control-element locations, factors influencing entrance and egress provisions, seat widths and advisable front and rear-compartment heights.

The author recommended the standardization of a range of locations for the different control elements.

This paper is printed in full on other pages.

Attention was called in the discussion to the necessity for allowing sufficient space between the rim of the steering wheel and the edge of the body seat. This is the width which determines the ability of the driver to enter and leave the car from the left side. In Goddard's paper he gives this dimension as 9 in. This is about an average but, in the discussion, it was pointed out that some cars have as little as 7 in. at this point.

Another point which was brought up in the discussion was that the location of the starter pedal should be very carefully chosen so that the driver would not step upon it as he entered the car. In certain locations this is apt to happen and if it occurs while the engine is running the results are apt to be costly, owing to the great danger of stripping the starter gear.

Quite a little interest was excited by the suggestion for a standardized dummy or mannikin to be used in determining the seat layout and dimensions of the front and rear compartments. L. C. Hill stated that at McCook Field, Dayton, a standardized aviator is used to help lay out the control system; in fact, he said a great many

ships had been built around the aviator mannikin with very satisfactory results. A point to be considered is that the mannikin has not the adaptability of the human frame and, consequently, allowance must be made for this fact. Whether this allowance should be in the form of making the dummy larger or smaller than the average man it was supposed to represent, was a debatable point at the meeting and there was some discussion on both sides.

The California Top

P. W. Steinbeck discussed California tops. This type of top, with which the industry is familiar, was designed very largely as a result of the California climate, where the days are warm and the nights cool. The top is a convertible type with a permanent top but removable side glasses. The early forms incorporated side glasses at the side and rear but a rolling curtain at the front adjacent to the driver's seat on both sides of the car.

The present type, as described by Mr. Steinbeck, has sliding side glasses which roll back into the rear glass and extend forward all the way to the windshield, giving a completely glassed-in body when desired.

W. C. Karns of A. M. Karns & Sons, criticised the California top because of the fact that the side glasses do not open with the doors. On a request for the cost of such a body as described by Mr. Steinbeck the latter stated that it would run between $350 and $650. Another inquiry was as to the advantage, with this cost, of this type of body over a sedan. The author replied that it had no advantage as far as body construction is concerned but, due to the climatic conditions requiring quick change from an open to a closed type of body, it is admirably suited to the climate of California or other places where sudden changes from heat to cold are experienced.

Harmony in Upholstery

R. C. Quaintance discussed harmony in car upholstery. Taking the artist's viewpoint, the author discoursed on the subjects of color, color harmony and the psychological effects of color, as a prelude to a discussion of how the decoration of car interiors can be made most effective, this being necessary because of the elusive quality of good taste, a quality of appraisal rather than one of creation, and because esthetic taste depends upon the degree of mental development of the individual, although possessed in some degree by all.

The primary, secondary and complementary colors were defined and their mode of selection described preliminarily to a consideration of color values and the selection of the most effective color-schemes, application of these principles being made thereafter to the decoration of car interiors, inclusive of comments on the most suitable fabrics and patterns. The author believes that color will be considered eventually in the automotive industry as being on an equal plane with lines and form.

In speaking of the decoration of car interiors he said, "It cannot be emphasized too strongly that, in the natural expression of refined taste, the purer color must be used sparingly and with great care. The tints and shades or tones are to be favored. The chief function of the purer colors is emphasis only or, if one can so refer to it, the purer colors are for punctuation only. While it is agreed by most students that complementary colors are harmonious, there are certain conditions that must be considered, chief among which is area. For instance, green is the complementary of red. For certain purposes this combination is an excellent one. When applying it to a closed-car interior, we must neutralize the dominant hue. Professor Munsell has compiled a color chart which shows that red is twice as strong as green in what he terms 'chroma'. In this instance, he says, we will regulate the area; so that our dominant color is green and considerably lowers the value of the red by darkening it. The green itself might well be grayed, preferably to an olive, and we then find, in applying the two complementary colors to a closed-car interior, that the color scheme has worked out to an olive-green cloth with a maroon stripe. It is a combination that is suggestive of spring and of the garb of nature and is representative of life, youth and freshness; a combination of warm and cold colors that is agreeable and restful, since the maroon stripe supplies sufficient life to tone up the combination.

"In passing it may be well to remark that nature supplies a wealth of harmony which must be studied to be appreciated. The student will observe quickly that nature employs a relatively small amount of pure colors. Even the beautiful sunsets are devoid of pure colors; all of the beautiful effects arise from ever-changing combinations of tints and shades.

"A point to be borne in mind in regard to harmony in car upholstering is the fact that the less obvious the color element is, the most quality the different tones possess. This is applicable equally to color harmony in other fields.

Warm Tones in Enclosed Cars

"The warmer tones are to be preferred for use in a closed car as against the colder tones. By those who have understood the subject, the warmer tints have been selected with a view to making the interior cheerful and inviting in its appeal, and to make it as pleasant as a well-appointed drawing-room in its season of greatest usefulness, winter. The same interior can be made cool, quiet and restful during summer, by the use of slip-covers having a color scheme based upon the cold side of the color circle. Slip-covers serve other purposes, chief among which is the protection of the upholstery from dust and dirt during periods in which the windows frequently are lowered when driving.

"A still different kind of color harmony that, I am sorry to say, is extremely popular with many car-builders, is what is termed a mono-chromatic group. This is made up of two or more tones of the same color. It is the most unobtrusive and conservative harmony scheme possible. It is always safe, but seldom interesting. There is, however, an even more severe treatment, that of employing a single solid tone. This practice requires painstaking care in the selection of laces, curtains, curtain cords and other trimming accessories to insure perfect matching. I have seen some excellent examples of this type in the products of custom body-builders, but I do not commend its use to large manufacturers. This treatment would not wear well with some personalities; it would become extremely monotonous and probably tiresome.

"In the mono-chromatic harmonies, those employing two or more tones of the same color and any other schemes except the solid tone, it is possible to give the interior that natural balance of light over darkness that is considered of prime importance in all decorative fields. In this case the floor covering would be of the darkest shade, the body cloth a trifle lighter and the trimmings and head lining, if one is used, of a still lighter shade. In interiors of this nature, it is possible to make the color scheme interesting by the use of one or more bright spots such as an enameled handle or vanity case, or by using other interior fixtures. This should be of a color complementary to the dominant color. If we must have mono-chromatic car-interiors, let us at least liven them up. If we insist that the cloth manufacturer supply us with fabrics containing two or more neutral shades, then let us liven up the interior by the use of color in other interior fittings.

"I wish to urge, however, that we be reasonable. Judging from the descriptions I have read of the cars shown at the recent Paris Salon, our European friends have achieved some remakably grotesque discords in this line; apparently, this is a reaction from the recent war. Some of the cars shown must have been extremely ludicrous; nevertheless, we can learn much from the Europeans. Not all of their creations are to be classed as freakish; in fact, all Latins are more artistic than Saxons as a rule and, generally, they are much more fond of color.

"There are three general types of fabric, cotton, wool and mohair. Of the first, cotton, little need be said. Cottons are used generally in the cheaper cars only, although the cotton velours had an extensive run in the medium-grade cars during the war period, as did the cottons also. These velours, while giving a rich luxurious effect, are not really serviceable. The mohairs woven from the hair of the angora goat are extremely serviceable and have enjoyed several years of popularity. But the fabric that seems to be the most desirable from all angles of style, wearing quality and appropriateness is the various kinds of woolen cloths. They vary in weaves and weights and a particular type can be found for any upholstery purpose.

"A point to be borne in mind when selecting fabrics is that any pronounced figure will soon grow extremely tiresome. The eye requires complete rest in a closed car, rest from the continuous motion outside. The influence of the interior should be one that is felt rather than seen; for this reason the brocades, tapestries and chintzes, or other furniture upholsteries, have no place in the correctly appointed motor-car. The pattern should be small and unobtrusive and appear in the body lining only.

"Some manufacturers have experimented extensively with woolen cloths and to-day are weaving a cloth on looms especially designed for automobile fabrics. Special finishing machinery has been built to impart a broadcloth finish to all woolen cloths. A fabric that promises to become extremely popular is the new worsted cloth. Some of this is all worsted, and some grades are only worsted faced. These cloths trim well and have unusual wearing qualities. Another new fabric that has great promise is the mohair sateen, a flat woven mohair. This can be made in a wide variety of shades and various patterns and, strange as it may sound, is guaranteed by the manufacturer to outwear the car.

A Plea for More Color

"In conclusion, I want to enter a plea for more color; more color in the interior and more color in the exterior. We literally have worked the funereal color, black, to death. For years we have painted the majority of our cars black. We have had too much of it. We should brighten the cars with color. As a result of the continued practice of using black, we have killed many an owner's pride in his car. When one drives home in a new car in these days, it is impossible to feel that one is creating any stir in the neighborhood. In fact, one's neighbor is very apt to remark over the back fence, 'I see you got the old bus washed up'."

Discussion on this paper brought out the fact that there was a live interest among manufacturers in getting away from the drab color scheme which has come to be part of production bodies. Due to the chemistry of certain colors, particularly blue, these colors have a tendency to fade more rapidly than others which necessitates using them with cars.

L. Valentine Pulsifer presented a paper on the Manufacture and Application of Automobile Varnishes and Paints. Pulsifer stated that the ability of an automobile finish to remain new is the product of four elements, the slighting of any one of which is bound to be fatal to satisfactory results. The four elements are the proper quality of the materials, engineering of the system, method of application, and care of the finish. The responsibility for these four essential elements is divided among three different interested parties, the maker of the varnishes and paints, the builder of the automobile and the owner of the finished product.

The automobile manufacturer is interested particularly in two phases of this preservation, the engineering of the system and the method of application. Given the proper quality, the manufacturer can secure good results if he properly lays out the system of application.

Materials for Painting

Five basic materials are used in automobile painting; those for priming, surfacing, coloring, rubbing and finishing. Each of these performs a distinct and different function and all are necessary to a complete painting operation.

The primer forms the bond between the surface to be painted and the subsequent coats of material; it is the foundation of the whole structure.

It must be of suitable nature to perform its duties properly and be applied over a surface properly prepared to receive it. The surfacing materials are used for the purpose of building up a smooth surface on which to apply the color, rubbing and finishing coats. There are two types, those surfaced by sandpapering and those by pumice. The latter are tougher and more dense and, although they require more time and labor, give more complete and durable results. Coloring materials include the so-called ground colors, Japan colors, flat colors or body colors. They form a dense, opaque ground on which to apply the subsequent rubbing coats. They are extremely rapid in drying, show no gloss and should be semi-porous in nature to permit the varnish of the first rubbing coat to penetrate to a certain extent. Rubbing materials comprise all types of clear and colored rubbing varnish and a preponderance of gum in their make-up gives them a hardness that permits of their being rubbed to a smooth surface. This is done preferably with pumicestone flour, a felt pad and water. They range from materials that air dry to rub overnight to those that take four days to reach the requisite hardness for proper rubbing down. The colored rubbing varnishes are either factory made by grinding the proper dry pigment into the varnish or shop made by the careful addition of japan color to the clear rubbing varnish. The type of rubbing varnish selected is gaged by the character of the work, the slower and more durable grades being indicated for the finer types of finish.

Finishing varnishes used in automobile work represent the most highly developed type of oleo-resinous varnish used for any purpose. They must work and flow faultlessly, dry within a reasonable time, present a surface of mirror-like smoothness and possess adequate toughness and elasticity to insure long life. Hardening to a final thickness of less than .001 in., they must protect the whole paint and varnish structure against all the elements, and only too often against the abuse or neglect of a careless or ignorant owner.

Body varnishes should be chosen for their paleness of color, freedom and safety of working, speed and perfection of flowing, speed of drying and hardening and relation to durability, fullness of body and brilliancy of finish. A different type of finishing varnish should be chosen for the hood, fender and wheels from that used on the body, since there is need for a varnish more resistant to the action of mud, water, oil, grease and soap than is required on the body.

Pulsifer in his paper brings out the necessity for properly engineering the paint system. The five basic materials outlined must be applied in proper combination into the finished paint structure. He points out that it is just as bad to pile on unnecessary coats as it is to leave off materials that are necessary to the system. Just enough coats should be specified to produce the desired degree of fullness of finish.

In laying out the system for a given job it cannot be overemphasized that the five basic materials must be chosen not only for their individual merit but for their ability to pull together. To obtain the proper correlation of the various coats the elasticity of the succeeding materials should be gradually decreased from the primer to the flat color and then gradually increased up to the finishing varnish. This result is obtained by using an elastic primer. Next, a coat intermediate in elasticity between the primer and the surfacer is used; it is the so-called half-and-half or elastic roughstuff. Then the surfacer itself, possessing less elasticity, is applied and next the flat color possessing practically no elasticity. This should be followed by gradually increasing the elasticity of the rubbing coats produced by making each succeeding coat lower in japan color or pigment content and, finally, capping the whole with a finishing varnish possessing the greatest degree of elasticity possible.

In discussing the method of application, of which there are four, namely dipping, spraying, flow coating and brushing, Mr. Pulsifer stated that the dipping process is used principally for the application of black baking japans. Spraying by air brush or air gun affords the best method for the application of the primer surfacer and flat color coats. Flow coating is a method of applying rubbing and finish varnish that was first tried on a very small car and now is in use in a number of large plants producing higher-grade cars. It has to be used cautiously, as in a great many instances it is not highly successful in obtaining the desired fullness and durability. Flow coating finishing varnish results in a thinner residual film than is produced by the proper brushing of the same varnish. The lack of fullness of a flow coated finishing varnish can be corrected by extreme care, but such care is hardly possible with piecework.

If time and space were no object there would be no choice in final results between proper air drying and proper forced drying. Care must be taken, however, against too great an application of heat or too rapid application of the heat, or too little moisture content for the amount of heat used, all of which will cause case hardening of the surface rather than proper hardening throughout.

Surfaces in finishing are either sandpapered or rubbed with block rubbing stone and water. Sanding surfaces should not be rubbed along with the use of water because they are too porous. The best practice on rubbing coats is by felt pad and water, as it gives the best combination of appearance and durability.

Some discussion was created by this paper on the desired number of coats, and Pulsifer emphasized the fact that too many coats is just as bad as too few because of the tendency toward cracking and chipping under the influence of the weaving of the body. He stated that for a long time it was considered meritorious to apply a great many coats to a body, but that experience has brought out the fact that this is not in the interest of durability.

Another point which was brought out into the discussion is that in cleaning it is much more preferable to use benzol than gasoline, because of the greater volatility of benzol. The same primer can be used for aluminum as for steel, but owing to the nature of aluminum surface it is highly important that it be properly cleaned if anything like a durable paint job is to be secured. It is particularly necessary that any solder which may be present on the body be cleaned off before the primer is applied.

Material Session

By J. Edward Schipper

DISCUSSION of materials entering into the makeup of automotive products occupied the attention of various members of the S. A. E. for an entire afternoon. Papers on chrome molybdenum steel, continuous die rolling, drop forging practice and malleable iron castings made a program which excited the interest of a number of metallurgical members of the Society.

C. N. Daw, metallurgical engineer, Studebaker Corp., presented a paper on "Chrome Molybdenum Steel Applications from the Consumers' Viewpoint." This concern has used over 2,000 tons of molybdenum steel of various analyses. This has been put through production in the form of rear axle shafts, transmission gears and shafts, steering knuckles, steering knuckle pins, ring gears, drive pinions and, in fact, for all alloy steel parts.

Mr. Daw states, in his paper, that by a process of elimination, it became clear that steel containing molybdenum approximating .30 to .40 per cent with chromium 1.00 per cent and carbon above .30 per cent should be avoided when water is desired as the quenching medium and where cracker shearing is used. An analysis, showing a carbon content below .30 and above .23 per cent with a chromium content of .70 to .90 per cent and molybdenum, .30 to .40 per cent gives satisfactory results with water as a quenching medium, there being no cause for concern pertaining to the development of quenching cracks.

A great number of tests were cited by Mr. Daw and his paper is largely concerned with the results obtained from these tests and with the prospects of other data which will be secured from subsequent tests. An extensive test was run involving the pulling of approximately 400 tension pieces turned from heat treated stock varying in size from ⅞ in. round to 2 in. square. The sizes used were ⅞, 1 and 1½ in. rounds and 2 in. squares. The three smaller sizes were obtained by forging down from the 2 in. square hot rolled forging bars. The 2 in. square test pieces were taken directly from the bar, no work having been put upon them.

The wide heat treating range of a given steel is a property upon which great stress always seems to be laid, but in Mr. Daw's tests he states that no attempt has been made to determine this for the reason that in this present day of accurate metallurgical control we do not need a 100 to 200 degree quenching range. What consumers are mostly interested in is to determine the lowest quenching temperature that can be commercially used and still obtain the maximum physical properties. With this in mind, quenching temperatures ranging from 1550 to 1650 deg. Fahr. were used in the case of the chrome molybdenum, chrome vanadium and chrome steels, while 1475 to 1575 deg. Fahr. were used in connection with the chrome nickel steel.

Mr. Daw interprets the results of his tests by means of the merit index suggested by H. T. Chandler and presented in a paper by John D. Cutter before the American Society for Steel Treating. This formula is as follows:

$$I = \tfrac{1}{2}\, e\, (E + S) \div (100 - R)$$

where

I = the merit index
e = the percentage of elongation in 2 in.
E = the elastic-limit in terms of 1000 lb. per sq. in.; in the tests it is taken as the yield-point
R = the percentage of reduction in area
S = the ultimate-strength in terms of 1000 lb. per sq. in.

A conclusion, drawn by Mr. Daw from his tests, is that chrome molybdenum steel for heat treated automobile parts has considerable merit. In view of the fact that this steel apparently can be produced in unlimited quantities, with no danger of shortage of molybdenum, and because it has been produced and sold at a lower price than its closest competitor, chrome vanadium steel, its adoption has been sanctioned. It forges entirely satisfactorily with the particular advantage that the scale formed breaks away from the forgings very easily. With proper composition, and for sizes within ordinary limits, it cold shears as readily as the other grades of commercial alloy steel. It responds very readily to the heat treating operations, and the percentage of forgings falling outside of the required Brinell hardnesses are very small.

With reference to its machining qualities, no figures can be given to corroborate the claims which have been made with regard to the reduction in tool cost. In tests of this type, there is always doubt as to the exact uniformity of the tools performing the tests, also the results obtained are very likely to be peculiar to a given shop and not applicable universally. The Studebaker Corp. has satisfied itself, by noting the machineability of the tonnage that has passed through its shops, that chrome molybdenum steel machines at least as well as the best there is. There has not been a failure insofar as the corporation has heard of any part made of this steel out of the 50,000 cars that have been thus far produced since its adoption.

To obtain the best possible results with case hardened molybdenum steel parts, it has been found necessary to quench from the carbonizing box into oil and follow this by the regular double heat treatment and a final draw at 375 to 400 deg. Fahr., timing each operation as carefully as possible. Mr. Daw draws attention to two particular advantages that should be noted in that chrome molybdenum will take on a given case depth in 10 per cent less time than chrome nickel steel. Also there will be a resultant average increase in Shore hardness of from 5 to 7 points. Despite the fact that the Studebaker Corp. has not received many complaints with regard to failures of case hardened parts of chrome molybdenum steel, it has seen fit to discontinue this particular grade for this purpose. Chrome nickel steel apparently still holds the first place among commercial steels for case hardening of important parts. It is the opinion of Mr. Daw, however, that nickel molybdenum steel will be a serious contender. Chrome molybdenum steel should prove entirely satisfactory for parts in which hardness alone is the chief factor but should be considered carefully before being used in important parts in which combined toughness and hardness are requisite, such as gears, steering knuckle pins and the like.

Considerable discussion on this paper brought out very strongly the fact that engineers and metallurgists believe the Brinell hardness to be an essential specification. John H. Nelson, metallurgical engineer of the Wyman-Gordon Co., brought out the fact that the Brinell hardness is used by a great many consumers for testing steel and, consequently, should be included in the tables. Ralph H. Sherry, metallurgical engineer of the Willys Corp., agreed with Mr. Nelson on the desirability of including Brinell hardness figures in the specifications. He also stated that he was not quite in agreement with the use of the merit index formula as a means of determining steel qualifications. A number of other members brought out the same objection but no suggestions as to another method of arriving at comparisons were offered. A question was raised as to whether the molybdenum steels referred to in Mr. Daw's paper were calcium molybdenum alloys or ferro molybdenum. It was made clear that these were manufactured with ferro molybdenum. In commenting on the merit formula, Mr. Nelson stated that he preferred all of the steels shown in one of Mr. Daw's tables to those contained in another, although the merit index does not make clear the superiority of these steels.

Continuous Die Rolling

G. R. Norton, in his paper on "Continuous Die Rolling," described this process of manufacture and the product possible with it. The improvements that have been made have been as a result of efforts to produce more complicated sections by this process with greater accuracy. The method is of considerable interest to automotive engineers in view of the fact that it has been very satisfactorily used for such structural parts as front axle I-beam blanks, and rear axle drive shafts. Mr. Norton illustrates in his paper front axle I-beam blanks that can be finished under one hammer for either the Elliott or reverse Elliott type of axle. He also mentions blanks for camshafts which are ready to strike for finishing thus eliminating the blocking or upsetting operation and the rolling in dies immediately preceding forging. Spring clips can be rolled with the offsets for bending exactly as forged. A small amount of flash is produced which requires cold trimming before the clips are bent. Rear axle driveshafts can be rolled and, after trimming, are ready for hardening and machining.

Drop Forging Practice

J. H. Nelson, chief metallurgist of the Wyman-Gordon Co., presented a paper on "Drop Forging Practice." He states, in his treatise, that the drop forging industry has contributed largely to the phenomenal growth of the automotive industry during the past decade. Drop forgings for automotive construction are made to-day in large quantities from a great variety of steels, both plain-carbon and alloy, the particular grade of steel used being dependent upon the part to be forged and the duty required of the part. With the increase in the number of forge-shops that has occurred within the last few years, it is no longer a problem to have a forging made, but rather to secure the necessary quality in the forging when completed; and this matter of satisfactory quality is not something that is apparent on the surface of the forging. Two forgings may be identical in appearance, size, shape, amount of finish and even forged from the same grade of material; yet, from a quality standpoint, they may be decidedly different. This difference may be due to any one or to a combination of the following factors:

1. Method of forging
2. Method of heating for forging
3. Inspection and supervision of forging
4. Inspection of raw stock
5. Segregation of raw stock
6. Heat-treatment of the finished forging.
7. Testing of the finished product

Inspection of Raw Stock

Inspection of raw stock should consist of (a) surface inspection to determine the fitness of the material for use in forgings, such as an examination for size, seams, scale, burns and the like, and (b) chemical analysis to determine the fitness for use in the various parts, to determine the segregation of the elements in the bars and to determine mixed heats.

Mixed heats are of two kinds, those that are deliberately mixed at the mill and those that are accidentally mixed at the mill. Under deliberately mixed heats, we find steels of the same grade but from different melts that are rolled into bars and furnished to a customer under the same heat number. Such heats are made up from ingots that have the same or nearly the same chemical composition, as to the hardening or alloying constituents. Heats of this character are of an endless source of trouble to forgeshops that endeavor to keep melts of steel of the same grade segregated. Unintentionally mixed heats are due to a few bars of a different grade of steel becoming misplaced. While this is a source of annoyance, it is readily detected chemically and the bars are then rejected.

Segregation of Raw Stock

Segregation of raw stock of the same grade by melts is absolutely essential if quality forgings are to be produced. It is not only necessary to segregate the stock in the yard but it is equally necessary to segregate the forgings made from the stock until they have been completely heat-treated and are ready to ship to the customer.

Nelson gave in his paper tabular data of the chemical analyses and physical properties of 107 different heats of carbon steel used recently. They show a variation in drawing temperature of 140 deg. Fahr. in steels of practically the same chemical composition to meet the same physical property specifications based on more than 1,000 tests on this grade of steel taken from production stock. Nelson drew the following five conclusions in his summary:

(1) Steels of the same grade and of the same chemical composition do not respond in the same way to heat-treatment.
(2) To heat-treat with minimum loss, only steels from the same melt should be included in a furnace charge.
(3) Stock subjected to heat-treatment should be carefully segregated into piles of the same melt, it should be kept segregated throughout the entire process of fabrication to produce satisfactory forgings of uniform quality.
(4) Tensile and hardness tests should be required on all heat-treated forgings to check the thoroughness with which the various heat-treatment operations were performed.
(5) At least one hardness test should be made on all heat-treated forgings to insure that all have responded to the heat-treatment operations in the same manner.

Ralph Sherry, metallurgist of the Willys Corp., called attention to the fact that in drawing by the use of the lead pot on a large scale, he has avoided variations in physical properties. He stated that it is difficult to attain uniform results with different types of furnaces, whereas with the lead pot it is possible to hold the temperatures within very close limits. In replying to this view, Mr. Nelson stated that this is solely a matter of temperature control and that by using balanced furnaces, uniform results can be obtained. He states that even in production it is possible to hold the temperature within a 5 deg. range. He is perfectly satisfied with the uniformity obtained in this way and believes that it is solely a matter of getting good furnaces accurately controlled. In the Wyman-Gordon plant, pyrometers are used at the front and rear end of each furnace.

Ralph Sherry stated that it was his experience with different furnaces held exactly uniform and checked by six pyrometers variable results were obtained, whereas, with the lead pot greater accuracy was secured at less cost. W. F. Graham, metallurgist of the Spicer Mfg. Co., supported Mr. Sherry's stand on the use of the lead pot. He also commented that it was necessary to take into consideration the percentage of carbon and manganese to determine the drawing temperature range. He stated that there are difficulties in the way when the carbon content is below .30, at which time the draw is practically eliminated.

Standards Committee Meeting

A SYNOPSIS of the meeting of the Standards Committee was given in our last week's issue. Practically all of the reports were accepted. Some proposals, however, met with opposition, and after the subject had been fully illuminated from both sides, a vote was taken and the recommendation was either accepted or referred back to the Division for further consideration. One of these items was that in the report of the Electrical Equipment Division regarding a change in the shaft extension for electric generators in connection with the flange system of generator mounting.

There are two sizes of this flange mounting, known as Nos. 1 and 2, respectively. The first is designed for a small size and the second for a large size generator. The dimensions of the flange and those of the shaft differ in the two. It appeared that some users of the small size generator have been calling for the flange intended for the large size generator, and this has compelled manufacturers of generators to make the small size generator with two different shafts; that is, the driving ends of the two shafts had to be different. This, naturally, is undesirable from the production standpoint, and it is also illogical from an engineering standpoint, because the torque to be transmitted is exactly the same in both cases. It was sought to remedy this difficulty by having the shaft lengths of both mountings changed so the two would be alike. Shaft diameters were not to be affected. There was determined opposition to the proposal on the part of one member, on the ground that only one of the mountings was intended for one size of generator, and if so used the difficulty which it was sought to remedy would not occur. The final result was that the item was referred back.

Several other reports engendered a fairly lively discussion. Among these was the report of the Roller Chain Division providing for revised minimum breaking strengths of S.A.E. roller chains. This report was presented by H. S. Pierce of the Link-Belt Co. Mr. Pierce explained that the proposed strength requirements were less severe than the present ones. The reason for the proposal was that manufacturers of chains, in order to be sure to obtain the ultimate tensile strength called for by the standard, used materials and processes which impaired the quality of the chain in other respects. The pins of the chains are case-hardened, and rather than use a very low carbon steel, which gives the best case, the manufacturers would use a steel with a higher carbon, which would give greater core

strength. The heat treatment also was adapted more to getting a strong core than a hard case. It was a fact, though, that to every chain that broke in service perhaps 5000 wore out, and resistance to wear was a much more important factor than ultimate tensile strength. A letter from the Morse Chain Co. was read opposing the proposal, on the ground that it would discourage the adoption of superior grades of steel in the manufacture of roller chains. The proposal was also objected to by M. C. Horine of the International Motor Co. He pointed out that the committee which drew up the proposal was a joint committee of the S. A. E., the American Society of Mechanical Engineers and the American Gear Manufacturers Association, and that the requirements in industrial transmission work had been given undue attention, so that the proposal really did not meet automotive requirements. He was of the opinion that the proposed strengths were too low; Hans Renold, when on a visit in this country some years ago, had said that even the requirements of the standard which it was proposed to cut were quite low. Any chain maker who would sacrifice wearing quality to high tensile strength would quickly come to grief, and he did not believe that the retention of the present standard would work out that way. Besides, foreign manufacturers of roller chains were beginning to make a bid for American business, and American chain makers would have to look to their interests. Mr. Pierce in reply said that the object of the committee was to check a bad tendency. The wearing quality of a chain depended on the quality of the case and the depth of same. A better chain was obtained by not aiming at too high ultimate strength, because the ultimate strength in any case was many times the maximum working load. The figures proposed for standardization were testing machine or static values, and, moreover, they were minimum values; average strengths were generally about 10 per cent greater. E. A. Johnston of the International Harvester Co. suggested that a table giving safe working loads would be a better guide to the designer than the proposed table of minimum tensile strengths, to which Mr. Pierce replied that the committee was taking up problems in connection with chain standardization one at a time, and that data on safe working loads was now being gathered. Upon this item of the report being put to the vote it was accepted, together with an amendment by H. M. Crane to the effect that the point that the values in the table were *minimum* values be made clearer.

Engine Numbers Proposal Adopted

There was also considerable discussion on the subject of engine numbers. The proposal of the Division has already been given in these columns. H. M. Crane expressed the view that numbers formed in the casting would be much more difficult to alter than numbers stamped on as proposed, but he admitted that casting the numbers on might involve difficulties in the case of those manufacturing engines for the trade. He wanted to know whether there was any objection to the S. A. E. standardizing two methods of numbering—casting on numbers for those who could use that method, and a second preference in the form of stamping numbers on in the way suggested in the report, for those whose practice did not admit of the first plan. J. B. Fisher of the Waukesha Motor Co., who presented the report, agreed that casting the numbers on was ideal, but the plan presented difficulties in the case of engine builders supplying engines to a dozen or more customers. A. J. Scaife of the White Motor Co. asked whether the approval of the Underwriters' Laboratories to the numbers had been received. It was replied that the Underwriters' Laboratories had asked for samples of the numbers for the purpose of testing them out, and these had been supplied them, but no report had yet been received. Mr. Burnett of the Standards Committee reported that a representative of the Underwriters' Laboratories had attended the meeting of the Division held in November, and had given it as his opinion that the proposed system of numbering was the most promising one heard of yet. C. O. Guernsey of the Service Motor Truck Co. suggested that the recommendation be referred back to the Committee until the approval of the Underwriters' Laboratories was obtained, because without this approval the method would have no practical advantage. H. M. Crane moved that the number proposal be made a recommended practice instead of a standard. In commenting on this Mr. Burnett said that the proposal was really a revision of an existing standard on Engine Numbers now on the records of the Society, but Mr. Crane disagreed, saying that the old system of numbers was merely for purposes of record, whereas the proposed system was a safety measure, and therefore was really a new subject. Rising votes had to be taken both on the amendment and the amended motion, the former being adopted by a vote of 11 to 10 and the latter by a vote of 14 to 9.

Fan Belts and Pulleys

Another item in the report of the Engine Division that stirred up considerable discussion was that on fan belts and pulleys. G. W. Gilmer of Philadelphia pointed out that fan diameter alone is no criterion of the size of belt required to transmit the power necessary to drive it. The fan belt width and the pulley width should be fixed in accordance with the power requirements. It is a mistake to put a crown on both the driving and the driven pulley, for the reason that it is impossible to get the two crowns absolutely in line, and the belt will then follow a crooked path. Only one of the pulleys should be crowned and that should be the driving one, because the crowning cuts down the contact surface, and in a fan drive the driving pulley is always considerably larger in diameter than the driven one and has more belt contact surface, hence cutting down this surface is not so serious a matter as it would be if the surface on the driven pulley were cut down.

In the report the terms fan drive and power drive were made use of, and Mr. Fisher was asked what was meant by these terms, and also how the angle for Vee belts recommended was arrived at. He said that the term "fan drive" applied to a drive for the fan only, whereas "power drive" was intended to apply to a drive to the fan and other accessories at the same time. The angle of Vee (28 deg. for power drives, 38 deg. for fan drives) was arrived at by averaging present practice.

A proposal was made by the Engine Division to extend the S. A. E. engine testing forms to make them applicable to stationary engines. It was suggested that on Specification Sheet B provision should be made for recording, under Item No. 32, Lubrication, the Saybolt viscosity at Cold Test, 150 deg. Fahr. and 350 deg. Fahr. A communication had been received from the Bureau of Standards protesting against the adoption of 350 deg. Fahr. It was pointed out that at that high temperature all oils would show practically the same viscosity. Standard temperatures for viscosity tests of 70, 130 and 210 deg. had been adopted by the Institute of Petroleum Technologists, and it was felt that these should be adhered to in determining the viscosity of lubricating oils. In favor of the recommendation it was urged that these standard viscosity temperatures had been fixed long before the advent of the automotive engine and that the conditions to be met in these engines could not have been foreseen. The temperature of 350 deg. was chosen because it was thought to represent very closely the temperature of the walls to be lubricated. The cylinder walls may not be as hot as this but the piston walls certainly reach that temperature. In opposition to the proposal it was stated that the oil on the piston and

cylinder walls in normal operation is not the same oil that is put into the crankcase. It is generally strongly diluted with condensed fuel and therefore has a materially lower viscosity than the oil put into the engine. The suggestion concerning the extension of the engine test forms was accepted as made, but on the following day, at the business meeting of the Society, on motion of H. M. Crane, the proposal to provide for the insertion of the item relating to the oil viscosity at 350 deg. Fahr. was stricken from the report.

Business Session

A DEVIATION from practice at previous S. A. E. annual meetings was made this year during the business session, in that each of the vice-presidents gave a brief review of the progress made in that particular branch of the industry which he represents. President Beecroft in opening the session said that while the Society was still young in years it was great in accomplishments. He called attention to the excellent program which had been prepared for the meeting, and extended congratulations to Chairman Scott of the Meetings Committee. A total of twenty-three papers had been secured for the meeting; for the first time practically all of the papers had been printed in advance and members and manufacturers who might be interested in any particular paper had been circularized. He welcomed Harry Ricardo as guest of the Society, Mr. Ricardo having come over to attend the meeting at the invitation of H. L. Horning. In giving a brief survey of the activities of the Society during the past year Mr. Beecroft expressed the view that the most important accomplishment had been the establishment of the Research Department.

Dr. Dickinson, who was to start the program of the session with a talk on Automotive Research in 1922, was unfortunately unable to be present on account of sickness in his family. H. M. Crane said that the greatest piece of work accomplished by the Society the past year had been the acquisition of Dr. Dickinson's services. Whether consciously or unconsciously, we all came to the meetings of the Society to meet other engineers and by contact with them learn something that would help us in solving the problems that confronted us. Unfortunately many of the younger members could not come to these meetings, and it was this that would make the research department be of great value. The idea which Mr. Crane conveyed was that members who seldom had the opportunity to profit by listening to the discussions at S. A. E. meetings should take advantage of Dr. Dickinson's familiarity with automotive literature and his experience in automotive experimental research to get help on their problems.

Progress of Aviation

Speaking on the progress of aviation, Mr. Crane said the past year had been a period of marking time. Still, the efforts here and abroad to adapt the airplane to commercial services had resulted in great forward strides. Attempts to use war machines for commercial purposes generally had ended in failure, but even these failures had proven instructive. Mr. Crane referred to the great handicap to the commercial exploitation of aircraft that lay in the lack of suitably located landing fields, illustrating this point by the actual experience of an acquaintance who traveled by airplane from the upper part of New York City to Atlantic City. Owing to what may be described as inadequate landing and terminal facilities the entire trip occupied four hours, whereas the train time between New York and Atlantic City is only three hours. Passengers board their train in the center of New York City, and the terminal station in Atlantic City is located right in the center of the hotel district. The importance of carrying passengers as near to their destination as possible was shown by the fact that the Pennsylvania Railroad, although it had three ferry connections with Manhattan Island before the construction of the Hudson tunnels, was willing to spend many millions of dollars for facilities enabling it to carry its passengers right into the center of the city. It seemed the company was compelled to do this by the competition of the New York Central Railroad, but subsequent events showed the investment to be a wise one.

Mr. Crane said that the past year had seen many new records made in aviation, of speed, altitude and endurance, but the most important records had been made in the U. S. Mail Service and in the transportation lines, both here and abroad. Records of the sporting type had their uses in stimulating the imagination and in arousing general public interest; they also furnished considerable engineering information of value, but the things that we need now, he said, are the knowledge of how to conduct a regular daily service at a minimum cost and fairly certain data as to what the cost of such service will be.

Conditions Affecting Passenger Car Field

B. B. Bachman, reviewing progress in the passenger car field, said that uncertain industrial conditions had had their effect on this development. The two outstanding problems had been the fuel problem and the highways problem. To the fuel problem a great deal of time had been devoted at the meetings of the Society and as a result much had been added to the knowledge of the fundamentals. As an example of the problems that would demand the attention of automotive engineers, Mr. Bachman stated that the city of Philadelphia recently had passed an ordinance prohibiting the parking of the cars in the city streets, which made it impossible for automobile owners, unless they were fortunate enough to have a chauffeur, to make use of their cars in transacting business in the downtown district. It behooved engineers to call attention to the absurdity of such regulations and to work for their repeal.

Joseph Van Blerck, in a report on the advances in marine engineering, said that when the S. A. E. inaugurated standardization in the motor boat field enthusiasm was high and interest keen. Many promising projects were undertaken and some of them were well started when the war interfered and it became almost impossible to get members together on this work. After the war, by the time the work could be taken in hand again, the present depression in business had set in, and the matter had been practically at a standstill. Old members were followed up with the idea of keeping the subject alive, and attempts to get new members in this industry were made, but with organizations shifting and personnel changing little success was attained. One of the things that intensified the depression in the marine engine business was that large numbers of old airplane engines were refitted for marine use. While no new standardization was accomplished during the year, the standards previously adopted were almost universally accepted, although there were certain exceptions to be noted.

A report on stationary engines was made by Theodore C. Menges. Mr. Menges divided stationary internal combustion engines into ten classes, as follows:

1. Large engines.
2. Electric light engines.
3. Pumping engines.
4. Concrete mixer engines.
5. Milking machine engines.
6. Railroad handcar engines.
7. Contractors' engines.
8. Air compressor engines.
9. Well drilling engines.
10. Farm engines.

Each class of engine was briefly described, and Mr. Menges' report also contained paragraphs on ignition, governors, cooling systems and lubrication.

E. A. Johnston, reporting on tractor engineering in 1921, referred to the effect of the drop in price of farm products on the sale of farm machinery. Price cutting in agricultural machinery, both domestic and foreign, he said, was carried to the limit by manufacturers, who sold much of their product below the cost of production. Foreign trade decreased to such an extent that it might be said that samples only were sold during the latter half of the year. The United States Government statistics showed foreign shipments in tractors as follows: January, 2500; February, 1500; March, 1170; May, 254; July, 58. Production naturally decreased noticeably, although there was a marked increase in the demand for tractors to be used for road making and for industrial purposes.

The lightening of tractors by the use of high grade materials and designs required more and more attention to wheels and lugs. Therefore, considerable work was done during the past year to establish the relative values of various types of lug, the widths and diameters of wheel, and the relation of speed to draft, although there is still much research work to be done along these lines. The generally accepted operating plowing speed is now approximately 3 m.p.h.

While many two-plow outfits had been produced, and these excelled in sales, there was a tendency toward a larger or three-plow tractor that would do 50 to 60 per cent more work at the same labor cost. Further, there was a marked tendency toward operating the wheels of a wheeled tractor in the furrow, which limited the width of the drive wheels to 12 in. for 14 in. bottom. This, together with the movement toward reduced weight, resulted in the more difficult problems of developing lug equipment, lubrication, and the meeting of the various conditions due to slippage and steering.

The ever present question of liquid fuel, its cost, supply and suitability, has caused a marked demand for alcohol developments. This call comes largely from foreign fields, where sugar refuse is available, such as the Philippines, Hawaii, Cuba, Brazil, Argentina, Esthonia and France.

Other reports received were those of the Standards, Membership, Meetings and Sections committees and the report of the Treasurer. The latter report this year for the first time was illustrated by graphs to give the membership a clear picture of the relation between the income and expenditures of the Society and a comparison of the various items of income and expenditure. The total income of the Society the past year was $242,846.11 and the total expenditures were $233,115.01. The Society owns Government and high grade railroad bonds of a par value of $100,000 and of an actual value of very little less. All reports were accepted. President Beecroft spoke on the Status of the Engineer in Automotive Economics and H. L. Horning on International Affiliation of Engineers.

Demonstrations at Industrial Shows

EXHIBITORS at industrial shows are coming more and more to a realization that demonstrations impressing the visitor with the most important qualities of the machine or products exhibited are a great sales help. Such demonstrations were given at the recent New York automobile show by a great number of exhibitors. The General Electric Co. gave demonstrations of its Genelite synthetic bearing bronze and its water japan.

One of the salient features of Genelite is its porosity, which makes it capable of absorbing 2½ per cent by weight of oil. To demonstrate this feature, three small stands were prepared, each carrying a beaker of oil on top, with a rod of Genelite, babbitt, and bronze, respectively, set in the beaker. Below was another beaker, and a wick connecting it to the top of the rod in the upper one. In the case of the Genelite, oil from the upper beaker was siphoned into the lower one by capillary attraction in the metal and the wick. In the cases of the bronze and babbitt there was no siphoning effect.

Another exhibit consisted of a small flywheel driven by a motor, and running in Genelite bearings. One of the pedestals was equipped with an electric heating unit, and two wells filled with babbitt on each side of the Genelite bearing. The pedestal was heated by the coil to a degree sufficient to keep the babbitt molten, without affecting the Genelite, which showed that the latter would operate without trouble at a much higher temperature than babbitt.

In connection with the water japan exhibit eight tests were performed to show its resistance to corrosion, and two to show its flexibility. The latter consisted of a bending test and torsion test. Strips of metal coated with japan were continually twisted and bent, to show how the coating stands such treatment.

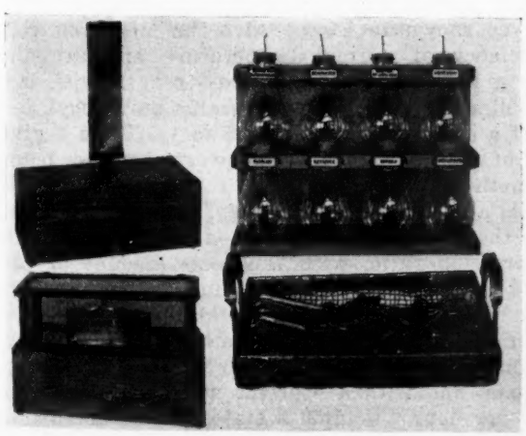

Exhibit of water japan

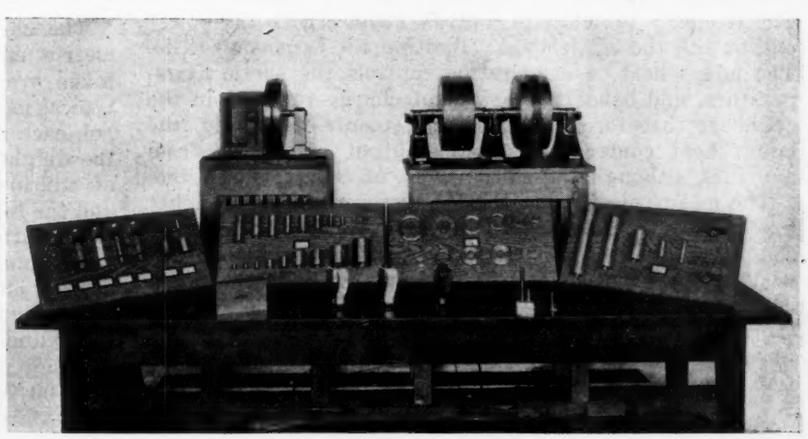

Exhibit of Genelite bearings

Recent Research Work on the Internal Combustion Engine

An important contribution, supplementing earlier reports which were published in these columns last year. The effect of latent heat of vaporization, mean volatility, temperature, pressure, dilution, mixture strength, stratification and other factors upon the combustion, and especially the detonation, of various fuels is discussed at length. Much other data given.

By Harry R. Ricardo*

IN this paper I propose to deal with the work that has been carried out recently at my laboratory, and with the deductions I have drawn therefrom. The deductions are based upon analyses of the evidence I have obtained to date; therefore, they represent the opinions I hold at the moment and, like all such deductions, are liable to be overthrown or superseded in the light of future work.

Fuels

We have been carrying out a great amount of research work on the subject of the influence of different fuels on the performance of an internal combustion engine, during the past few years. The experiments have all or nearly all been carried out on single cylinder engines, into which the problems of distribution do not enter. Therefore, until we have more data on this very intricate subject, I can deal only with the conclusions reached in so far as they are applicable to single cylinder engines. The three most important factors appear to be

1. Tendency of a fuel to detonate.
2. Latent heat of evaporation of the liquid fuel.
3. Mean volatility of the fuel.

Broadly speaking, it can be said that all volatile hydrocarbon fuels have the same heat value per cubic inch of mixture giving complete combustion and that, therefore, the power obtainable from all is the same within very close limits when used at the same compression ratio and at the same volumetric efficiency. The limit of compression ratio is determined by the tendency of the fuel to detonate; it is a function both of the chemical composition of the fuel and of the maximum flame temperature. The tendency to detonate controls at once both the power output and the efficiency, by limiting the expansion ratio. The latent heat of evaporation controls the suction temperature, and hence the weight of charge retained in the cylinder; therefore, for the same compression ratio, the latent heat controls the power output obtainable from any fuel, although the efficiency is, of course, unaffected.

The mean volatility of the fuel determines the use that can be made of the latent heat of evaporation, because the lower the volatility is, the greater the amount of heat becomes that must be added externally to the cylinder, and the more the weight of charge will be reduced thereby. It does not appear to be realized generally how important a part the latent heat of evaporation of a liquid fuel plays in the performance of an internal combustion engine. During the suction stroke of a four-cycle engine, heat is added to the working fluid by

1. Preheating the carbureter and induction system.
2. Contact with the hot valves and cylinder walls.
3. Admixture with the hot residual exhaust products in the cylinder clearance space.

Heat is abstracted only by the latent heat of evaporation of the liquid fuel.

For any given aggregate value of 1, 2 and 3, it does not matter whether the fuel is evaporated inside or outside the cylinder, so far as power output is concerned, provided only that the fuel is completely evaporated before the inlet valve closes. In the former case, the heat applied to the carbureter and induction system will raise the temperature of the air without evaporating the fuel; in the latter, it will evaporate the fuel without raising the temperature of the air. However, in either case, the amount of heat absorbed by the evaporation of the liquid fuel will be the same; and the final suction temperature, and therefore the weight of charge retained in the cylinder will be the same also.

So far as pure hydrocarbon fuels are concerned, the latent heat of evaporation is low and does not play a very important part; but, in the case of ethyl alcohol, and still more so in the case of methyl alcohol, the very high power output obtainable is due almost entirely to the high latent heat of the liquid, which is playing an even more important part than is apparent at first sight from a comparison of the mean effective pressure available, because the total internal energy of the alcohols is appreciably lower than in the case of gasoline, benzol and other hydrocarbons.

The curves shown in Fig. 1 give the measured volumetric efficiency at normal temperature and pressure, taken over a wide range of mixture strength with both typical gasoline (see Fig. 1), and nearly pure ethyl alcohol, each at a compression ratio of 5 to 1. Table 1 gives the weight of charge per hour, the power output per pound of mixture, the indicated m.e.p. as found experimentally and the total available internal energy, in the case of tests made with the same three fuels, when each is run at the same compression ratio, with the same amount of preheating and at a mixture strength giving complete combustion. Column 1 gives the observed weight of charge entering the cylinder per hour at a mixture strength that permits complete combustion. Column 2 shows the observed i.hp., at 1500 r.p.m. and with a "correct mixture," per pound of mixture per hour. Column 3 states the observed indicated mean pressure, at correct mixture strength, in

*Condensed from a paper presented at the Annual Meeting, Society of Automotive Engineers.

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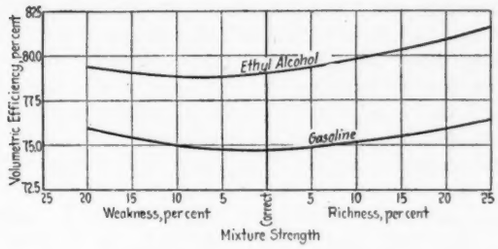

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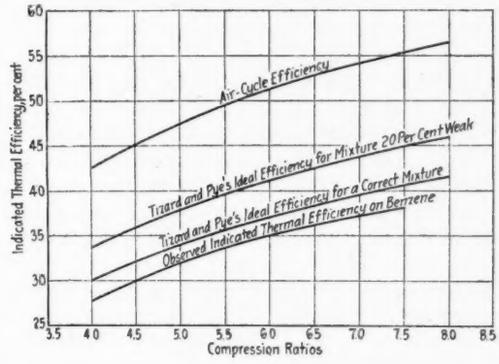
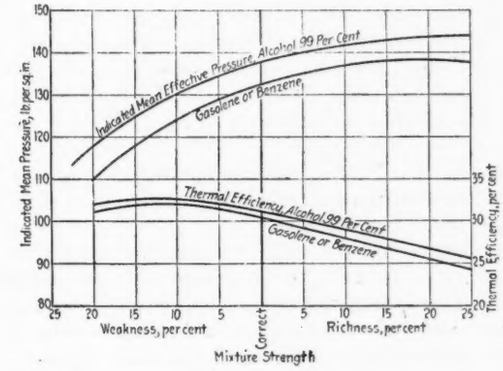

Indicated Thermal Efficiency, per cent
Air-Cycle Efficiency
Tizard and Pye's Ideal Efficiency for Mixture 20 Per Cent Weak
Tizard and Pye's Ideal Efficiency for a Correct Mixture
Observed Indicated Thermal Efficiency on Benzene
Compression Ratios

3


Indicated Mean Pressure, lb per sq in.
Indicated Mean Effective Pressure, Alcohol 99 Per Cent
Gasolene or Benzene
Thermal Efficiency, Alcohol 99 Per Cent
Gasolene or Benzene
Thermal Efficiency, per cent
Weakness, per cent
Correct
Richness, per cent
Mixture Strength

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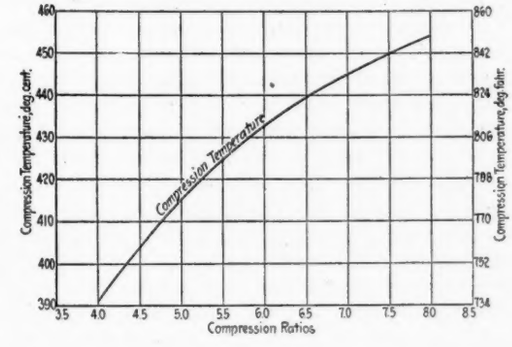

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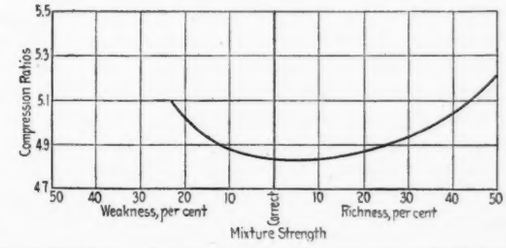

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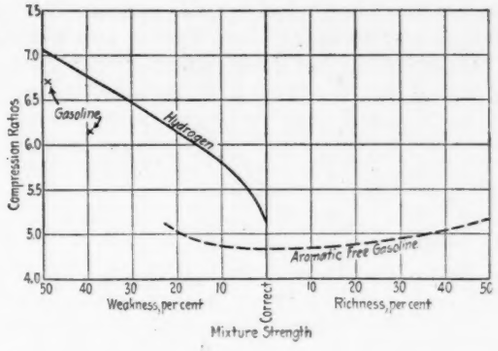

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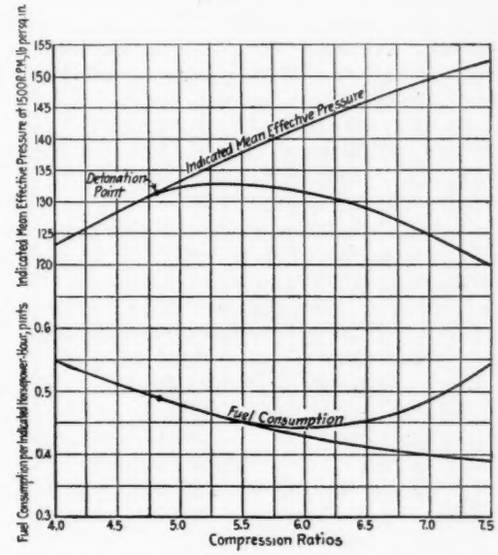
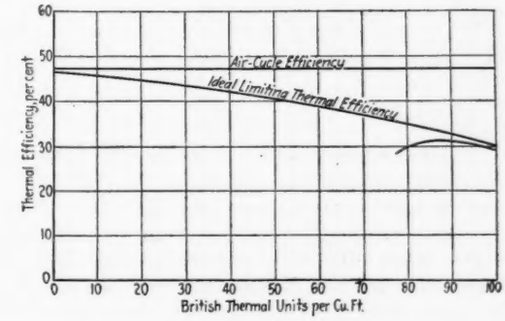

Indicated Mean Effective Pressure at 1500 R.P.M. lb per sq in.
Detonation Point
Indicated Mean Effective Pressure
Fuel Consumption per Indicated Horsepower-Hour, pints
Fuel Consumption
Compression Ratios

10



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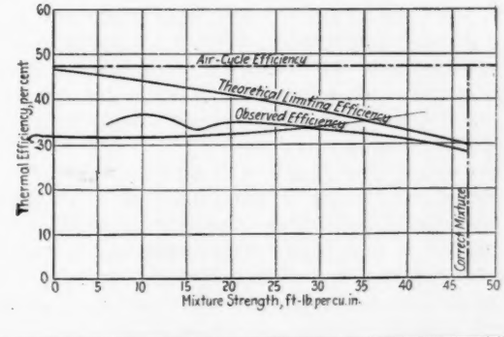


Fig. 1—Volumetric-efficiency and mixture-strength curves for a typical gasoline and nearly pure ethyl alcohol. Fig. 2—Indicated thermal efficiency for various compression-ratios. Fig. 3—Indicated mean effective pressure and thermal efficiency for various mixture-strengths of heptane, benzol and alcohol. Fig. 4—Curve showing the compression temperature for compression-ratios ranging from 4 to 1 to 8 to 1. Fig. 7—Curve showing the compression-ratio at which the detonation-point becomes apparent with varying mixture-strengths of aromatic free gasoline and air. Fig. 8—Compression-ratio at which the detonation-point becomes apparent with varying mixture-strengths of hydrogen and aromatic free gasoline as well as two points obtained with a stratified charge of aromatic free gasoline. Fig. 9—Indicated mean effective pressure and fuel-consumption curves obtained by adding varying quantities of additional exhaust-products. Fig. 10—Curves showing relation between the theoretical thermal efficiency and the energy content of the mixture. Fig. 12—Efficiency-mixture-strength curves obtained from the tests on this engine

pounds per sq. in. Column 4 presents the calculated heat of combustion of the fuel in foot-pounds per cu. in. at normal temperature and pressure. The engine speed is 1500 r.p.m. and the heat input is 0.0433 B.t.u. per revolution.

Table 1—Identical Tests with Three Different Fuels

Kind of Fuel	1 Weight of Charge Per Cylinder Per Hour, Lb.	2 I.hp. Per Pound of Mixture Per Hour	3 Indicated Mean Pressure, Lb. Per Sq. In.	4 Heat of Combustion, Ft.-Lb. Per Cu. In.
Gasoline	209	0.153	132	48.2
Benzol	212	0.151	132	47.6
99 per cent ethyl alcohol	224	0.149	138	47.4

It will be seen from Table 1 that, although the power output on ethyl alcohol is greater than on gasoline or on benzol, the power output per pound of charge is actually somewhat lower. I have debated this question of the influence of the latent heat of the fuel upon the power output obtainable, because I think it is a very important one which does not appear to have been appreciated, and the influence of preheating does not appear to be fully realized. Many designers appear to be under the impression that, so long as the gases in the induction manifold are reasonably cool, the power output of an engine is not being penalized. This is a great fallacy. Table 2 gives the i.m.e.p. obtained at 1500 r.p.m. from the same group of fuels, with a compression ratio of 5 to 1, a correct mixture strength and an engine temperature of 15 deg. Cent. (59 deg. Fahr.). Column 1 is at a constant heat input of 0.0433 B.t.u. per revolution of 0 deg. Cent. (32 deg. Fahr.); Column 2, when preheated to give a temperature in the induction pipe of 25 deg. Cent. (77 deg. Fahr.); and Column 3, the temperature in the induction pipe with each fuel and with a constant heat input of 0.0433 B.t.u. per r.p.m. The difference between Columns 1 and 2, in the case of alcohol, is sufficiently striking to need no comment.

Table 2—Indicated Mean Effective Pressure and Temperature of Inlet Gases

Kind of Fuel	Indicated Mean Effective Pressure 1 Lb. Per Sq. In.	Indicated Mean Effective Pressure 2 Lb. Per Sq. In.	Temperature 3 Deg. Cent.	Temperature 3 Deg. Fahr.
Gasoline	132	133	26.0	78.80
Benzol	132	128	7.7	45.86
99 per cent ethyl alcohol	138	119	16.5	61.70

Since the internal energy, and therefore the flame temperature, are substantially the same for all fuels at the same mixture strength, it follows that the thermal efficiency will be the same. The available range of mixture strength on the weak side is also substantially the same for all the available volatile liquid fuels; so, in effect, we can say that the thermal efficiency is the same in all cases, with the exception of the members of the alcohol group. These, owing to their lower heat value per gram molecule and higher latent heat, yield a somewhat higher efficiency, because both the compression temperature and the rise of temperature after compression are considerably lower; hence, the direct heat losses and those due to change of specific heat are reduced.

Before proceeding further, I will add a few words as to the method of calculating thermal efficiency. It is generally agreed by engineers and scientists that the useful calorific value of a fuel is its total heat value less the latent heat of evaporation of the water formed. It is customary, therefore, to reckon the efficiency on the basis of this lower calorific value. It is legitimate to do so, because the temperature cannot be extended sufficiently in ordinary cycle to make any use of the heat of condensation of steam.

In determining the heat value of any liquid fuel in a bomb or other calorimeter, some of the heat of combustion is devoted to overcoming the latent heat of the liquid and is therefore not recorded. In an engine working on the explosion cycle, the entire amount of the heat required to evaporate the liquid is supplied either by the exhaust or by some other source of waste heat; in any event, it is supplied externally to the heat cycle and the actual heat of combustion available is greater than that found by the ordinary methods to the extent of the latent heat of evaporation of the liquid. Therefore, I contend that if it is legitimate to deduct the latent heat of evaporation of the water formed because it cannot be used, in common fairness the latent heat of the fuel should be added to the calorimeter determination because its equivalent value in the heat of combustion can be and is used in the case of explosion, but not of Diesel, engines.

Some two years ago Messrs. Tizard and Pye completed a very thorough investigation into the limiting efficiency obtainable in a gasoline engine, assuming no loss of heat to the cylinder walls but taking fully into account the losses due to increase in specific heat and to dissociation. They traced very carefully the degree of dissociation and recombination throughout the entire combustion and expansion process, and were thus able to arrive at very nearly the true ideal efficiency for any fuel. Their findings, based upon the latest researches in thermo-chemistry, represent probably by far the most accurate information available at the present date. Briefly they show (*a*) that the efficiency obtainable with any hydrocarbon fuel is the same when burnt at the same compression ratio, within extraordinarily narrow limits; (*b*) that the ideal efficiency for a chemically correct mixture is as given by the equation $E = 1 - (1/r)^{0.288}$; and that, for a mixture strength 20 per cent weak, it is as given by the equation $E = 1 - (1/r)^{0.295}$.

Fig. 2 gives Tizard and Pye's ideal thermal efficiencies for a range of compression from 4 to 1 up to 8 to 1; also, the air standard efficiency.

It will be seen that both the theoretical and the observed efficiencies rise with an increase of compression at a greater rate than the air standard, as the latter is increased and the terminal temperature reduced, due to further recombination during expansion. Tizard and Pye's deductions, as calculated for heptane, benzol and alcohol, cover a wide range of fuels in effect, and the whole available range of mixture strength for each. For the weakest possible mixture consistent with complete combustion, they have assumed a 20 per cent excess of air. We have been unable to obtain sufficiently rapid or complete combustion with so weak a mixture as this and, in practice, we found that the highest thermal efficiency is always obtained with a 15 per cent excess of air in the case of all the fuels we have examined, except ether and hydrogen.

Fig. 3 shows the observed variation in both mean effective pressure and thermal efficiency over a wide range of mixture strength for the same three fuels. It will be seen that in each case the maximum thermal efficiency is obtained with a mixture strength about 15 per cent weak beyond which the efficiency falls away due to slow and incomplete combustion. Even with a 15 per cent excess of air, it was found necessary to advance the ignition to become some 15 deg. earlier, that is, from 32 to 47 deg., than that required for a mixture giving complete combustion. In all these experiments the fuel and air consumption per cycle were recorded automatically and simultaneously.

Mean Volatility

While it would appear that the vapor pressure determines the readiness or tardiness of a fuel to start from a cold condition, it is the mean volatility which decides the amount of preheating required. When considering various fuels, it is desirable to divide them into two groups; those which are homogeneous, such as benzol or alcohol,

and those which are heterogeneous, such as gasoline or kerosene. With the homogeneous fuels, comparatively little preheating is required because, although their vapor tension and latent heats may be high, their final boiling point is low; and, since the object of preheating is primarily to prevent precipitation of the liquid on the walls of the induction system, it is necessary only to raise the temperature of these walls to above the boiling-point of the fuel. When the boiling point is low, it is possible to raise the whole surface temperature of the walls to a sufficient degree without adding much heat to the mixture flowing within.

In the case of fuels having a wide range of boiling points, such as gasoline, and with a final boiling point of any value up to 230 deg. Cent. (446 deg. Fahr.), it is very difficult to prevent precipitation and, at the same time, avoid imparting too much heat to the mixture, for, although the mean volatility of high boiling point gasoline and benzol may be, and actually is, nearly the same, the temperature required to prevent precipitation of the heavier fractions is much higher in the case of gasoline, and for the latter only high temperature heat is of much use. It would appear that in the case of high boiling point gasolines it is best to apply a little high temperature heat just at those points where, owing to changes in velocity or direction in flow, precipitation is most liable to occur, while in the case of the homogeneous fuels low temperature heat will suffice. There can be no greater mistake than to suppose that, because a fuel's latent heat of evaporation is high and its vapor tension relatively low, it requires excessive preheating.

Vapor tension governs ease of starting but, once started, it probably has very little further influence; thorough pulverization and the avoidance of precipitation then become the most important considerations. This is particularly marked in the case of alcohol which, if properly handled, requires very little preheating; but it does require the most thorough pulverization.

Detonation and Turbulence

The principal factor controlling both the power output and the efficiency of any internal-combustion engine operating on the explosion cycle is the tendency of the fuel to detonate. It is, therefore, not unnatural that so much thought and experimental research have been devoted recently both in the United States and in England to the study of this subject. The phenomenon of detonation appears to be the setting-up in the cylinder of an explosion wave. This occurs when the rapidity of combustion of that portion of the working fluid first ignited is such that, by its expansion, it compresses before it the unburnt portion. When the rate of temperature rise due to compression by the burning portion of the charge exceeds the rate at which it can get rid of its heat by conduction, convection and the like by a certain margin, the remaining portion ignites spontaneously and simultaneously throughout its whole bulk. This sets up an explosion wave which strikes the walls of the cylinder with a hammer-like blow and, reacting in its turn, compresses afresh the portion first ignited. This raises the temperature of that portion further and, with it, the temperature of any isolated or partially insulated objects in its vicinity; thus, it soon gives rise to preignition. Therefore, it would appear fairly certain that detonation depends primarily upon the rate of burning of that portion of the charge first ignited, and it remains to discover what actually controls this rate.

I have always maintained in previous publications that turbulence has an important influence upon the tendency to detonate. This seemed probable, and there was much circumstantial evidence in favor of this assumption. From more recent investigations, my belief in this has been considerably shaken. I now feel bound to confess that I can find no real evidence that turbulence, while invaluable for other reasons, influences detonation one way or the other. In the case of combustion-chambers designed to give very high turbulence, I found a marked reduction in the tendency to detonate, but I am satisfied now that in each case this was due not to the turbulence but rather to the fact that, in each instance, the maximum distance that the flame could travel from the spark-plug was exceptionally small. More recent tests on two engines with multiple valves, in which the turbulence could be varied by cutting out one or more of the inlet valves, showed that this made no difference whatever as regards detonation.

It was supposed until recently that detonation is dependent upon the temperature of compression; this appeared plausible enough at first sight, but it most certainly did not fit in with the observed facts. For example, the difference in compression temperature between a compression ratio of 4 to 1 and 6 to 1 is actually only about 40 deg. Cent. (104 deg. Fahr.), and this difference can easily be more than counterbalanced by a change in the amount of preheating of the charge; but, we all know from experience that, while detonation on say a reasonably good gasoline will not occur with any amount of preheating at a compression ratio of 4 to 1, it will inevitably occur far below a compression ratio of 6 to 1 without any preheating at all, and even with stone cold cylinder jackets. The curve in Fig. 4 shows the compression temperature for a range of compression ratios from 4 to 1 to 8 to 1, assuming (*a*) the same amount of preheating and the same latent heat in every case, and (*b*) allowing for the varying proportion and temperature of the residual products at each compression ratio.

Our experiments appeared to show pretty clearly that detonation has very litte connection with the temperature of compression, but is closely dependent upon the compression pressure. Therefore, I concluded that it is the pressure rather than the temperature of the working fluid which controls the initial rate of burning, and therefore the tendency to detonate. This seemed reasonable. It fitted in nicely with the facts of the case and did duty as an explanation until the chemists objected on the ground that the rate at which chemical reactions take place is generally influenced but little by relatively small differences of pressure. It then became necessary to cast about for another explanation, and to find one that would satisfy the chemists also.

For the purpose of such an investigation we designed and built a machine for igniting fuel-air mixtures by adiabatic compression alone, and in which either the temperature or the pressure of compression could be varied at will over a wide range. A sectional drawing of this machine is shown in Fig. 5. In this apparatus the piston is operated by a toggle mechanism in such a manner that it makes one rapid stroke and then remains locked at the top dead center. By varying either the pressure or the temperature of the charge within the cylinder, a condition could soon be found under which any fuel-air mixture would just self ignite. It was found with this machine that, for every specific fuel and for any mixture strength of that fuel with air, there was a fairly definite temperature at which self ignition occurred. This self ignition took several forms; for example, at x minus 5 deg. Cent. (9 deg. Fahr.) the mixture would start to burn immediately on the completion of the compression, but would burn so slowly that the pressure would actually fall slightly, although not so rapidy as when no combustion took place, of course. Such burning would often continue for a matter of 2 or 3 sec., the rate of heat supply not

wholly balancing the rate of heat loss. At, say x deg. the same phenomenon would be observed at first, but with the difference that the pressure would fall slightly for the first 0.25 sec.; it would then rush up almost instantaneously to a maximum at which combustion would be complete.

This is shown in the typical diagrams in Fig. 6. If the temperature were raised a further degree or two, the interval of slow burning at nearly constant pressure would

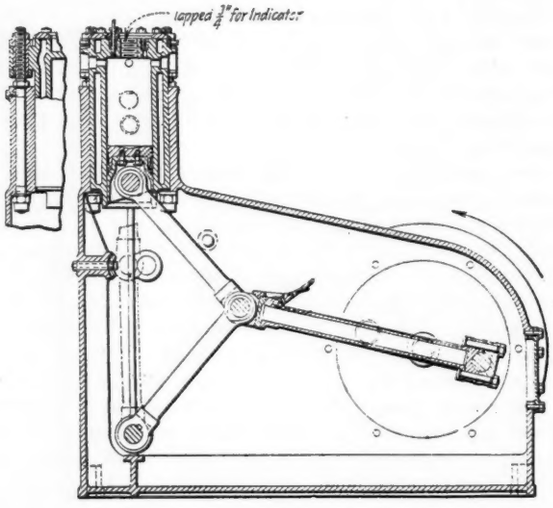


Fig. 5—Sectional elevation of a machine developed by the author for igniting fuel-air mixtures by adiabatic compression

be reduced to perhaps 0.10 sec. Thus, between the most timid and hesitating, and the most prompt and decisive burning, there would be found in each case a range of temperature of perhaps about 30 deg. Cent. (54 deg. Fahr.); but, since it was possible to vary the compression temperature within fine limits, this range could be explored very thoroughly. It was most extraordinarily consistent and, for any given mixture strength or any given fuel, one could adjust the machine beforehand with the certainty that one could obtain a 0.10, 0.20, or even a 1.00 sec. interval between the commencement of combustion and the sudden pressure rise. These first tests were all run with a stagnant charge; later a fan was fitted inside the cylinder and driven at a speed of about 2500 r.p.m. by a small electric motor. With the fan revolving, precisely the same phenomena were observed, and at nearly the same compression temperature; but the intervals between the commencement of burning and the sudden pressure rise, although relatively the same, were much smaller in all cases. In short, the fan speeded up the whole process; but it did not alter perceptibly its character, nor the temperature at which combustion occurred.

These investigations have been carried out very recently at our laboratory by Mr. Tizard. Since he has not yet had time to prepare his work for publication, it would not be fair for me to enlarge upon it; but he has made public some of the conclusions he reached, and they have been so amply confirmed, not only by tests on our own research engines but also by their close agreement with general experience, that there seems to be little doubt as to their correctness. Briefly, Mr. Tizard's conclusions are that, for any given fuel

(1) Detonation depends primarily upon the rate of burning of that portion of the charge first ignited; in this he confirms the usually accepted theory

(2) The rate of burning increases very rapidly with a slight increase of the flame temperature; and whether it will prove sufficiently rapid to produce detonation, depends upon the ratio between the rate of evolution of heat by the burning mixture and the rate of heat loss

(3) The rate of burning of the first portion of the charge depends, so far as practical engine conditions are concerned, upon neither the temperature nor pressure of compression, but rather upon the flame temperature

(4) For any given mixture-strength, the maximum flame temperature depends primarily upon the proportion of diluent or exhaust products present. It depends also, of course, upon the compression temperature; but this varies very little over a wide range of compression ratio, while the variation in the proportion of residual exhaust products over the same range exerts a much greater influence in diluting and so lowering the temperature of the initial flame. Thus, a difference of $\pm$ 1 per cent by weight of exhaust diluent will raise or lower the flame temperature by about 25 deg. Cent. (45 deg. Fahr.), which is equivalent to a range of compression from 4 to 1 to 5 to 1

(5) If the flame temperature be reduced by weakening the mixture strength, a very much higher compression could be used at once. In practice, with the exception of hydrogen, it is not possible to weaken the mixture so as to effect any appreciable reduction in the flame temperature because, within the narrow range available, weakening the mixture with air results merely in reducing the amount of dissociation without affecting appreciably the flame temperature

Fig. 7 shows the observed variation in the compression ratio at which detonation become apparent over a wide range of mixture strength. In this experiment the engine was run with wide open throttle at constant speed and constant temperature, and the compression ratio was adjusted at each mixture strength until detonation just became apparent. With both hydrogen as a homogeneous charge and with a stratified charge of aromatic free gasoline, it was found possible to operate at a compression ratio of about 7 to 1 with a mean mixture strength 50 per cent weak, and without the least trace of detonation. Fig. 8 shows a similar test with hydrogen, but with the mixture strength much further reduced, as is possible only with this fuel. On the other hand, with hydrogen the range of burning on the rich side could not be explored because, as soon as any excess of hydrogen was admitted, backfiring occurred through the inlet valves.

It will be seen that the new theory, although based on much sounder reasoning, squares with my older theory; and that, in the case of a normal homogeneous mixture, the tendency to detonate depends, in effect, upon the compression pressure, not, as I supposed, because the pressure has any marked influence, but rather because, in any actual engine, the compression pressure is, in itself, a measure of the proportion of inert diluent present in the cylinder. It differs in practice only when, by the use of hydrogen, by stratifying the charge or by the introduction of inert diluents, a weak mean mixture strength can be used. Mr. Tizard's theory has been further confirmed by other tests that we have run, in which

(1) The residual exhaust products have been cleared away by scavenging with air; it was found then that detonation became severe at once, even with very low compression pressures

(2) Additional exhaust products were added, by way of the carbureter; the compression could be raised then to almost any degree, depending upon the quantity admitted

Fig. 9 shows the variation in compression ratio permissible when, to a gasoline detonating normally at a compression ratio of 4.85 to 1, varying quantities of additional exhaust products were added and the compression adjusted in each case until detonation just became

apparent. Other tests using nitrogen, steam and carbon dioxide have given similar results. The effectiveness of such inert gases appears to be closely proportioned to their specific heats; that is, to their direct influence upon the flame temperature.

Broadly speaking, it would appear from our experiments that two factors determine whether or not a fuel will detonate. These are (*a*) the self ignition temperature of the fuel air mixture and (*b*) the rate of acceleration of burning as the ignition temperature is exceeded.

Both the true self ignition temperature, if indeed such a term can be used, and the rate of acceleration of burning appear to depend primarily upon the chemical composition of the fuel. As a broad generalization, our experiments confirmed that, as regards groups, the paraffins are the worst offenders from the viewpoint of detonation, the napthenes are better, the olefins better still, the aromatics next and the alcohols the best of all. This, however, can be regarded only as a very broad generalization, because the individual members of the various groups behave very inconsistently among themselves. Thus, pure pentane will withstand a compression ratio of 5.85 to 1 and is, in fact, comparable with a napthene. Pure hexane detonates at a compression ratio of 5.1 to 1, but pure heptane will barely withstand even a 3.75 to 1 ratio, which is the lowest compression we could reach. The behavior of heptane is particularly striking. The first samples used were obtained from California, from a vegetable source; and, although on investigation they were found to be pure samples of normal heptane and not isomeric forms, we still felt some doubt. Later, and with great difficulty, some small quantities of heptane were isolated from aircraft gasoline. Later still, some further supplies were obtained from Germany from Galician oil. Both these later lots of samples gave exactly the same results. Therefore, it will be seen that, while the average of these three members of the paraffin series agrees reasonably closely with the results obtained from a nearly pure light paraffin gasoline, the individual effects are widely different. The same thing could be observed in the case of the aromatics, where toluene was markedly better than xylene, and xylene was markedly better than benzol. The majority of the experiments on which the above conclusions are based were carried out on our 4½ x 8-in. variable compression research engine.*

Stratification

Careful analysis of the behavior of the working fluid in an internal combustion engine cylinder, shows that under ordinary circumstances, we must not look for an efficiency relative to the air cycle of more than about 70 per cent., at ordinary compression ratios. The principal sources of loss are

(1) Increase of specific heat at high temperatures
(2) Dissociation with incomplete recombination during expansion
(3) Direct loss of heat to the cylinder walls

These amount collectively to an absolute minimum of 30 per cent. In practice they generally approach nearer to 40 per cent.

Each and all of these sources of loss are directly dependent upon the flame temperature, and more particularly the flame temperature, during combustion, for we must be careful to distinguish between loss of heat during combustion and that lost during expansion.

With any volatile liquid fuel and, with the exception of hydrogen, with such gases as we have examined, the range of burning on the weak side is so narrow that the maximum flame-temperature cannot be reduced to any appreciable extent. Any attempt to do this with a homogeneous mixture results merely in slow and incomplete combustion. Flame lingers in the cylinder, and the fresh charge is ignited on entry. This sets a definite limit to the range that can be used on the weak side, but the practical limit is reached before this when, owing to delayed and incomplete combustion, the thermal efficiency falls off as the mixture strength is reduced. Fig. 3 shows the variation in thermal efficiency with mixture strength, over a wide range. Within exceedingly narrow limits, these relations can be said to hold good for any volatile liquid fuel we have ever encountered. It is indeed very surprising that, no matter how the chemical or physical characteristics of a fuel may vary in all other respects, they all apparently have this one characteristic in common, namely, that the highest thermal efficiency is always obtained with an excess of air about 15 per cent, with the one very striking exception of hydrogen. If, by any means, it were possible to work with a weaker mixture and still retain equally rapid and complete combustion, the flame temperature would fall in relation to the proportion of fuel present.

Benefits of Weak Fuel Mixtures

It would appear that, if the mixture could be weakened to an unlimited extent, the efficiency would rise from about 70 per cent of the air cycle in a nearly straight line until, with a mixture strength 15 per cent weak at the point of no heat supply, it would become coincident with the air cycle efficiency, much as is shown in Fig. 10. But this is not all, for, as the mixture strength and therefore the flame temperature are reduced, so also is the tendency to detonate; hence, if means could be found for extending the range of combustion on the weak side, and an engine were designed to use always a somewhat weak mixture, a very much higher compression ratio could be employed.

I have always believed that the benefits of working with a weak mixture could be realized by the employment

*A cut of this engine was published in AUTOMOTIVE INDUSTRIES for Sept. 15, 1921.

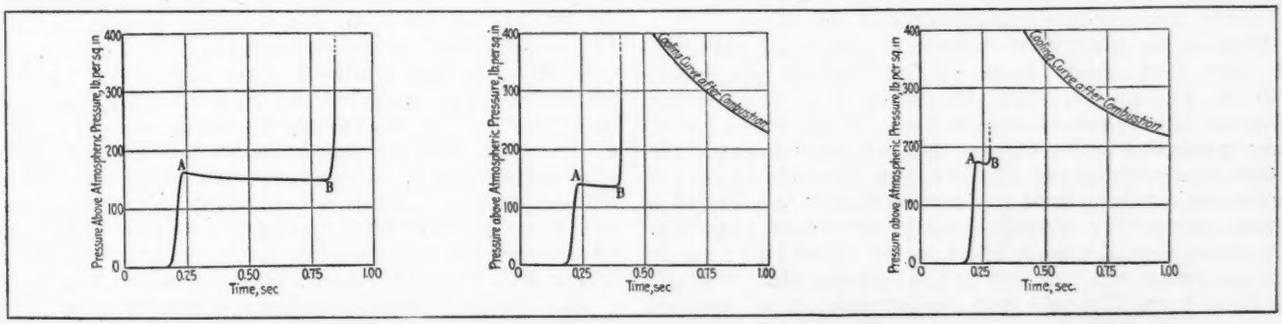


Fig. 6—Three typical indicator-diagrams of a heptane-air mixture obtained with the fuel self-ignition machine shown in Fig. 5. Reading from left to right the maximum compression temperatures were 282 deg. cent. (540 deg. fahr.), 310 deg. cent. (590 deg fahr.) and 307 deg. cent. (585 deg. fahr.). In the central diagram the fan was running at full speed. While in the other two it was stationary

of stratification; that is to say, by using a little relatively rich mixture and a large proportion of pure air, and keeping the two separate until after the ignition of the former. I have succeeded in doing this experimentally, and in approaching very nearly the results which theory would lead one to expect. In fact, I did this so easily and obtained such excellent results at the first attempt that I was at first misled into supposing that I could apply it to existing engines. Subsequent bitter experience has shown that I had a very unusual measure of good luck in my first attempt. I use an engine with a conical combustion chamber in which the air inlet and exhaust valves are fitted, and a small pocket connected with the main combustion chamber through a narrow neck.

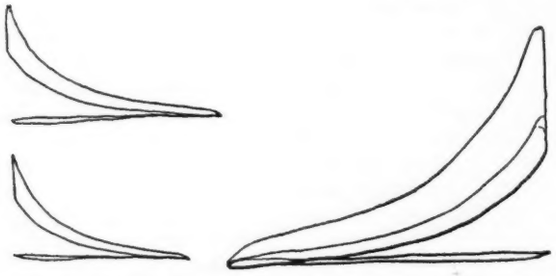


Fig. 11 — Three indicator-cards obtained with the stratified charge engine

An automatic inlet valve for the admission of a little fuel and air, and the sparkplug, are fitted in the pocket. The main air inlet valve is set to open rather late. The result is that, as the piston descends during the suction stroke, the automatic inlet valve in the pocket or bulb opens first, and air and fuel are drawn in through a throttle valve from what can be termed the simplest possible expression of a carbureter, that is, a plain uncompensated jet in a choke tube. About 20 per cent down the stroke, the main air valve is opened and thereafter pure cold air enters the cylinder below the pocket. At the time when the main air valve opens there is a considerable depression in the cylinder, and it is probable that any rich mixture that has overflowed from the pocket retires back into it when the depression is relieved. On the compression stroke, the contents of the cylinder are compressed and some air is driven into the bulb, creating great turbulence therein. The mixture in the bulb is fired at the end of compression and, owing to the turbulence, it burns with extraordinary rapidity. The flaming mixture then rushes out through the narrow neck where it meets and immediately mixes with a very large excess of air; thus, by igniting a small proportion of rich mixture in the first place, I succeeded, in effect, in igniting a large volume of very weak mean mixture strength. The power output of this engine could be varied, either by the quantity of fuel alone, or by varying the proportion of mixture of nearly constant strength admitted to the bulb.

With either method of control, the engine would run at any load from light to an i.m.e.p. of about 120 lb. per sq. in.; but, to obtain the best thermal efficiency throughout so wide a range, it was found necessary to combine both methods. All this seemed beautifully simple and wonderfully effective, and the running of the engine on the light loads was almost exactly like that of a steam engine for smoothness and sweetness generally. The experimental engine had a water cooled bulb; but it had no water-jacket or fins on the cylinder and, although of 5-in. bore, it would run continuously at an average m.e.p. of about 20 lb. per sq. in. without blistering the paint on the cylinder walls, while the exhaust, although somewhat free, sounded almost like deep breathing. In Fig. 11 a number of indicator diagrams taken from this engine are shown.

Fig. 12 shows the thermal efficiency obtained from it with a compression ratio of 4.8 to 1 and when running at a speed of 600 r.p.m. So far, everything seemed satisfactory and, indeed, so far as this one engine was concerned, it certainly was satisfactory, the only defect being that, do what I would, I could not avoid a small zone of relatively low efficiency over some part of the range. I could vary the position of that zone up and down the range, but I could not eliminate it. Next, I tried the experiment of fitting similar bulbs to several engines with different types of combustion head, merely substituting the bulb in place of the spark plug. This proved a disastrous failure in every case. At certain loads, generally at about one-quarter load, I could obtain a very high efficiency indeed; but this was counterbalanced by a miserably low efficiency and irregular running at other loads and, in most cases, I failed utterly to carry more than from one-half to two-thirds the load of which the engine was ordinarily capable. Subsequent experience showed that everything depended upon the

(1) Shape of the combustion chamber below the pocket
(2) Shape and size of the neck connecting the pocket with the combustion chamber
(3) Position of the sparkplug in the bulb

The dependence upon (3) is remarkable, in view of the excessive turbulence set up in the bulb; but it has proved very sensitive, none the less. During the war I was forced to discontinue experiments along these lines, but I was able to devote much time to experimenting with a supercharging engine in which I made use of stratification to a limited extent. After many initial difficulties, this eventually proved to be very satisfactory. Since the war I have had little opportunity to return to these experiments. However, some two years ago, I did convert one of the two high speed gas engines supplying power to the laboratory, to run with a stratified charge, but I was careful to fit a cylinder head and bulb exactly similar to that which I used on the first engine. This has proved to be entirely successful after about twenty months of continuous running. The engine runs in parallel with a sister engine similar in every respect, but operating with a homogeneous mixture and throttle governed. There is no comparison between the two in general behavior.

Fig. 13 is a sectional drawing of this gas engine. On the one hand, the engine using a homogeneous charge requires a top overhaul and having the exhaust valve reseated every two months. The engine using a stratified charge has had its cylinder head removed only once in twenty months. The exhaust valve was found to be in excellent condition at that time. There was no carbon on the piston, there being only a little coating of thick oil of the consistency of tar that could be wiped off with a rag, thus leaving the pistion clean and bright. When running in parallel on a fluctuating load, but with an average load factor of about 50 to 60 per cent, the governing on the gas supply alone has proved perfectly satisfactory. The only defect is that, while its sister engine will develop a maximum brake m.e.p. of 100 lb. per sq. in., the engine using a stratified charge will not do more than about 80 lb. per sq. in., showing that it has not the overload capacity of its sister engine. Incidentally, this engine also will run without a trace of detonation on aromatic free gasoline up to a m.e.p. of about 80 lb. per sq. in., despite the fact that its compression ratio is 6.5 to 1, thus supplying additional evidence in favor of Tizard's theory about detonation.

As a result of these experiences, I believe there is little doubt that, sooner or later, the system of working with a stratified charge will become commercial, for, as I have shown, this is possible and can approach the high efficiency

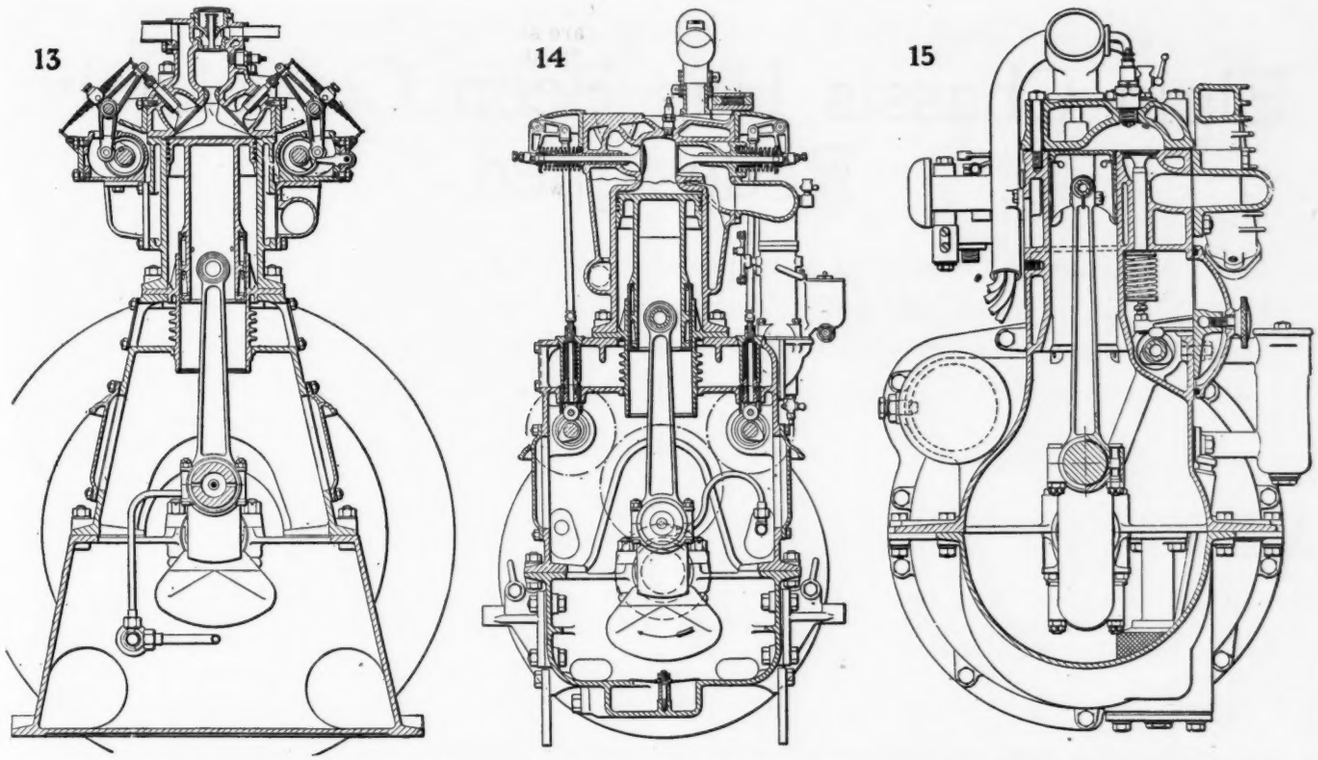


Fig. 13—Sectional elevation of the stratified charge gas engine. Fig. 14—End elevation, partly in section, of the 225-hp. Ricardo tank engine. Fig. 15—Elevation, partly in section, of a 11.9-hp. engine. The form of cylinder-head was adapted for all side-valve engines since it produced additional tubulence during the compression stroke and also the maximum distance from the point of ignition to the farthest point in the combustion-chamber

theoretically obtainable. The worst feature about it is that, if not just right, it may be very wrong; a very small change in form or dimension may upset the whole system. In such a case the thermal efficiency may very easily be much worse than that of a throttle governed engine. It will not be a commercial proposition, I fear, until the influence of each of the variable factors has been determined separately and evaluated correctly.

The great value of turbulence lies, in my opinion, in the

(1) Speeding-up of the process of combustion by the mechanical distribution of flame
(2) Scouring effect it produces in washing away the stagnant layer of gas adhering to cylinder walls

It appears now to be clearly established that the normal rate of burning of a fuel air mixture is, at the start, far too slow to be of any value; however, as shown by our experiments on the adiabatic compression machine, its acceleration after a certain stage is extremely rapid. It is probably in speeding up the initial stages of combustion by spreading mechanically the pale and timid flame brought into life by the spark plug, that turbulence plays its most important part, and this becomes most conspicuous when operating with weak mixtures.

Again, there is much presumptive evidence to show that, in any combustion chamber, there is always a layer of gas adhering to the walls of the chamber which, owing to its proximity to these walls, can get rid of its heat so rapidly that it does not burn completely. The effective thickness of this layer depends very largely, no doubt, upon the degree of turbulence. It appears to be this factor rather than the greater direct heat loss which renders certain forms of combustion chamber commonly used with side valve engines so inefficient. There is much to be said in support of this theory, because it explains the very marked difference in efficiency and power as between a high and a low degree of turbulence in the same combustion chamber, even when using relatively rich and prompt burning mixtures and firing from two points. Also, while the efficiency obtainable from two forms of combustion chamber of much the same surface area may be very different, the heat loss to the cooling water is generally much the same in both cases, showing that it is in the proportion of heat rejected to the exhaust that the difference in efficiency appears to lie rather than in that lost to the cylinder walls.

We have found the form of combustion chamber used in the 150 hp. tank engine* remarkably efficient from the viewpoint of power output and efficiency, for, with a compression ratio of only 4.3 to 1 we were able to obtain, both in the Mark Webber* and in the tank engines, a brake mean effective pressure of 108 lb. per sq. in. and a fuel consumption of only 0.55 lb. of gasoline per b.hp-hr. in the Mark Webber single-cylinder and of 0.57 in the six-cylinder tank engines. But we always found it bad from the standpoint of detonation; so bad that in the larger and later tank engines we decided very reluctantly to abandon it in favor of a much more compact form using horizontal valves, and with the spark plug in the center, as shown in Fig. 14. This gave about equal results as regards efficiency and mean effective pressure, but was remarkable as regards its freedom from detonation; in fact, these large engines would run comfortably even on kerosene with a compression ratio of 4.3 to 1 and without any cooled exhaust products. Later, we adopted the form of head shown in Fig. 15 for all side valve engines. This has proved the best of all side valve engines we have tried, for it produces additional turbulence during the compression stroke and, moreover, the maximum distance from the point of ignition to the farthest point in the combustion chamber, the factor which apparently controls detonation beyond all others, is about the smallest possible. It appears to combine the virtues of both the forms of combustion chamber we used in the tank engines.

NOTE.—The paper as presented included nine appendices containing much valuable research data.

*See paper by H. L. Horning, AUTOMOTIVE INDUSTRIES, June 2, 1921.

Elgin Chassis Has Been Completely Redesigned

New Model 7Q0 is fitted with special Falls engine, a new single plate clutch, larger fan and radiator, and new hand brake on the gearset. Cutler-Hammer automatic gearshifter is furnished as an extra when desired. Higher gear ratio, made possible by lighter weight, improves economy.

By P. M. Heldt

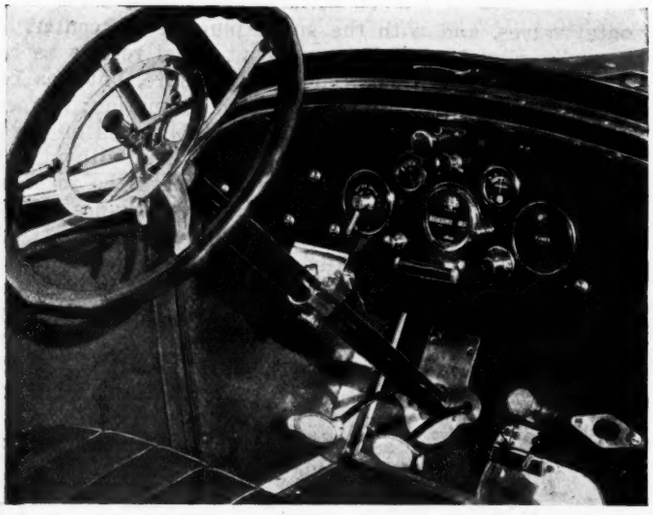
ALTHOUGH the cylinder dimensions of the new Elgin model are the same as those of its predecessor, it is practically an entirely new design. The engine is the Falls Special, a six-cylinder valve-in-head type of 3⅛ by 4½ in. By changing from circulating splash to force feed lubrication and making some other improvements the peak horsepower has, it is claimed, been increased from 37 to 46. The engine now peaks at 2700 instead of 2400 r.p.m. A new Stromberg carbureter, which gives a greater range at both the upper and the lower end of the speed, is fitted. A hot spot is now provided in the manifold, and this is claimed to result in higher torque throughout the speed range, but especially at the ends.

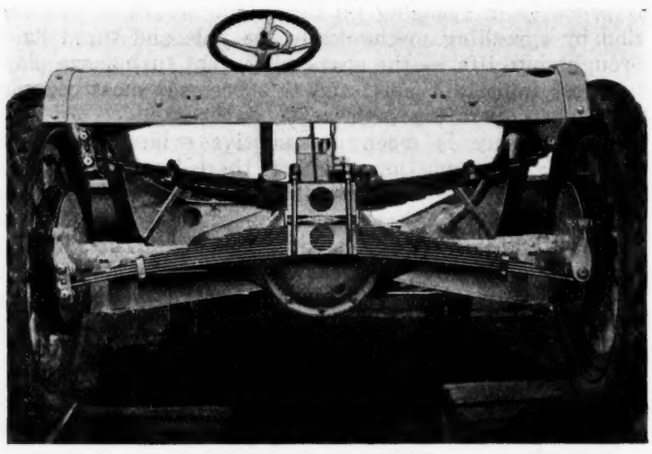
The Remy ignition system with both hand and automatic advance is now used, while the Westinghouse generator and starting motor are continued. The Willard battery also is continued, but instead of a 95 ampere-hour a 100 ampere-hour battery is now furnished. An increase in the height of the radiator of about 2 in. has added materially to the core area, and this, together with an increase in the fan diameter from 14 to 15 in. and the substitution of a Vee belt for the flat belt, has greatly added to the cooling capacity, making allowance for the increased output of the engine. On the fan there is now provided an adjustment which requires no tools. Circulation is by thermo-siphon, the same as last year.

The clutch, which is of the single dry plate type, and is made by the Rockford Drilling Machine Co., has an improvement in the way of an equalizer which divides the pressure equally between the three levers. There has been no change in the transmission, which is combined with the engine and clutch into a unit power plant that is supported on the main frame at three points. The Snead propeller shaft assembly, consisting of a tubular, electrically heat-treated propeller shaft and fabric disk type universal joints, is used. Driving thrust and torque reaction are taken up on a torque member made up of two channel steel members which are joined to the rear axle housing at the hubs of the brake spiders and come together in a forked end in front which has a ball joint attached to the cross member of the frame on which the rear end of the power plant is supported.

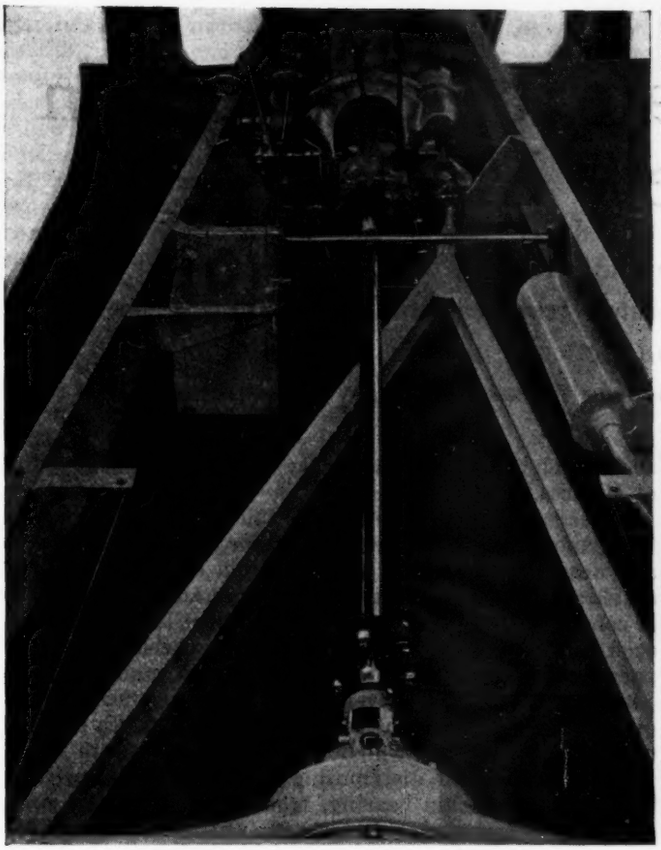
The power plant is set at a slight angle, to obtain a straight line drive when the car carries a normal load. The use of fabric joints, of course, makes it specially desirable that the angularity of the drive be minimized. The forward end of the torque member is almost the same distance from the axis of the rear axle as the forward universal joint, with the result that there is very little pulling and pushing action in a fore and aft direction on the disks of the joint.

This year the emergency brake is placed on the transmission and only the service brake is located on the rear wheels. In placing the hand brake on the transmission, several advantages were aimed at. The braking action of a transmission brake is equally divided between the two rear wheels without any special equalizing mechanism. Removing the brake from the rear axle reduces the unsprung weight. A transmission brake is easier to operate, requiring less effort to apply. Furthermore, placing one of the brakes on the transmission cleans up the

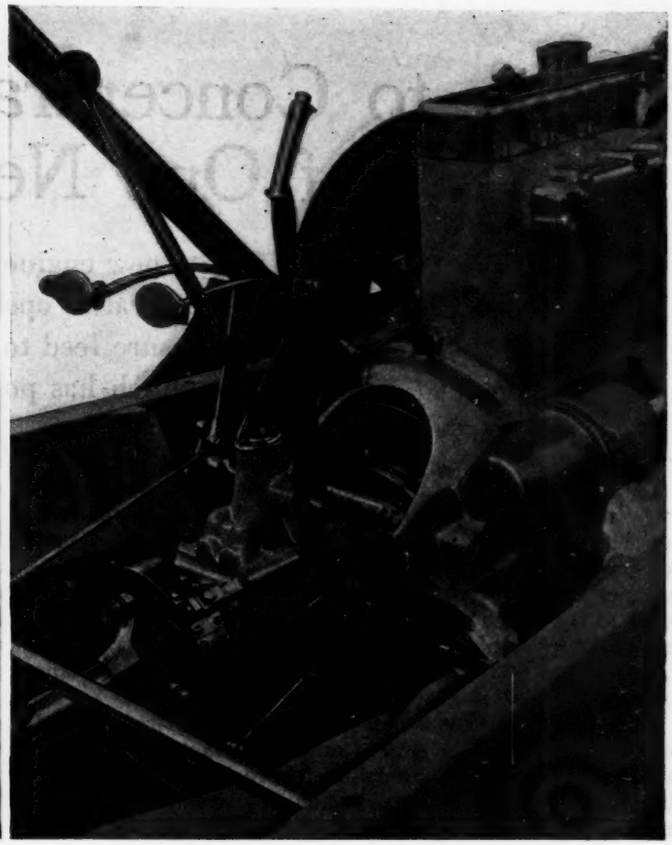




On left—Driver's compartment of car fitted with automatic gearshift. Note selector lever on steering wheel and brake pull rod on instrument board. On right—Rear X springs



Central portion of chassis showing torque member



Engine, transmission and emergency brake

chassis, in that fewer long brake rods are required, and incidentally the transmission brake is cheaper. The rear wheel service brake, which is of the band type, is 14 in. in diameter. A small rubber cushion is provided on the brake so that it goes on gradually.

The gear ratio has been reduced from 4.6 to 4¼ on the open models. This was made possible by the fact that this year's model weighs about 100 lb. less than last year's. As a result of the lower gear ratio the engine has to make fewer revolutions per mile and the fuel economy is somewhat increased. Last year the Elgin Motor Car Co. used cantilever springs at the rear, but this year it uses the type known as X springs, which consist of two half elliptics clamped together at the middle, one end of each spring being pinned to the frame rear cross member and the other end shackled. The two shackled ends are both at the same side of the frame. One of the two members of the spring is made considerably stiffer than the other, which is claimed to produce a damping effect, dampening out oscillations. The rear axle, which is of the same make as last year (Columbia), is somewhat lighter.

Some changes have been made in the steering gear which is the product of the C. A. S. Products Co. The reduction ratio of the worm and wheel, which was formerly 7 2/3, has been increased to 8½. This gives a more favorable condition in the gear, which is made with three leads and heavier teeth. A double bearing is now used on worm shaft—one bearing on each side of the worm. The connection between the worm wheel shaft and the steering arm is made by a serrated joint. A ball thrust bearing is now provided in the front axle spindles to ensure greater ease of steering. The frame is made of lighter stock but deeper section.

As an extra the company furnishes the Cutler-Hammer mechanical control. This is of the type in which a change in gear which may appear to be indicated by road conditions ahead, can be selected by means of a small lever on the steering wheel, and later the change made automatically when the clutch is withdrawn. This dispenses with the usual gear lever, and in order to remove all obstructions to ingress and egress from the driver's compartment, the emergency brake in this case is applied by a pull rod projecting backward from the instrument board.

The body of the new model is made a little longer and its sides and backs are higher. The top lines of the body are the same distance from the ground, but the bottom edge is closer to the ground than in the last year's model. The lines are somewhat similar to those of last year's model, the body being of the stream line type. A change has been made from the built-up type of crown fender to the one-piece type. The top is of the clear vision type, no sockets being exposed at the sides. At the front end the top curves in, in conformity with the lines of the body.

The equipment now includes a Stewart speedometer and a windshield wiper and Moto-Meter are now furnished on all models, instead of only on the closed models as heretofore. An electric primer (the Master) has also been added. The weight of the open touring model has been reduced to 2550 lb. A one-piece windshield, which swings around an axis close to the top edge, is now furnished.

ACCORDING to correspondence in *Engineering Production* there are four plants in Czecho-Slovakia producing automobiles. These employ together about 100,000 hands and turn out 5000 automobiles and 400 motor plows annually. The production seems exceedingly low for the number of men employed.

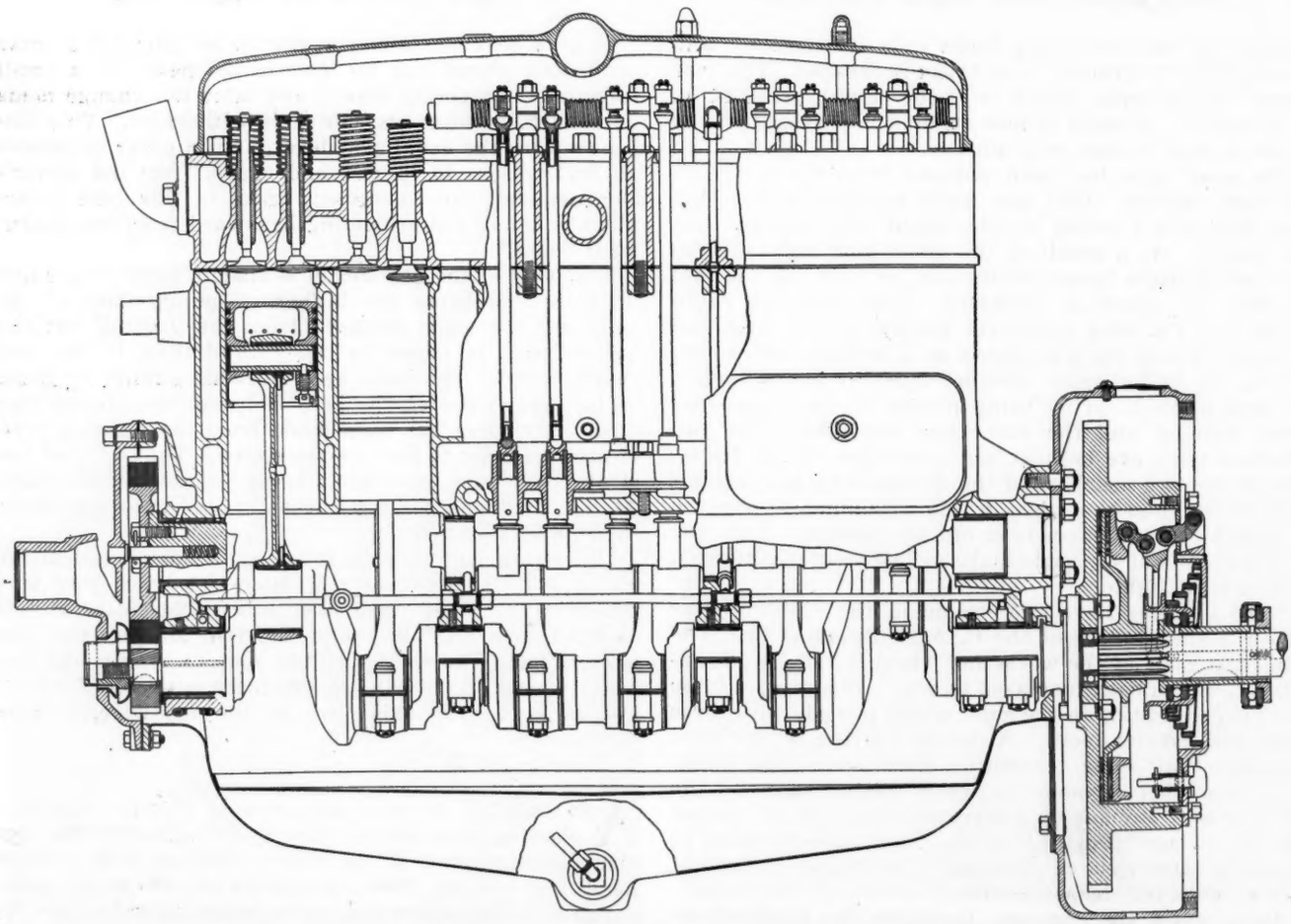
Velie to Concentrate on Production of One New Model

This is to be fitted with a new engine and clutch of their own manufacture. Engine has overhead valves operated from camshaft in crankcase, and is provided with pressure feed to practically all bearings, piston pins included. Single plate clutch has positive release and easy adjustment.

THE Velie Company has announced that its entire manufacturing facilities will be concentrated on the new Model 58, with 115 in. wheelbase. The chassis has been modified somewhat to accommodate the new powerplant, which is of Velie manufacture. It is a six-cylinder overhead valve type. Much thought has been devoted to the development of effective means of fuel vaporization. The cylinder head casting is so designed that the incoming gas mixture impinges upon exhaust heated walls to assist vaporization.

A desire to secure accessibility, good lubrication and smoothness of operation were governing factors in laying out the new engine. The cylinder bore is 3⅛ in. and the stroke 4¼ in., giving total piston displacement of 195.6 cu. in. and an N. A. C. C. rating of 23.4 hp. Timing gears are 9 pitch and are helically cut; the camshaft gear being of Micarta.

A gear pump is used to provide full pressure lubrication. The pump is mounted on the generator drive shaft housing and draws oil through a strainer from the oil pan in the crankcase. The oil from the discharge side of the pump is conducted to a distributing pipe, which leads the oil to each main bearing. The drilled crank cheeks provide a path for the lubricant to the bronze-backed connecting rod bearings. The upper halves of the big end connecting rod bearings are drilled to receive small copper tubes clipped, to the side of the rod, which lead oil under pressure to the wristpins. The oil distributing line is provided with a T, at the third main bearing, from which a branch leads oil to the hollow rocker arm shaft. Oil issuing from this



Longitudinal section of the new Velie engine and new single-plate Dooley clutch. Note large size of bearings employed

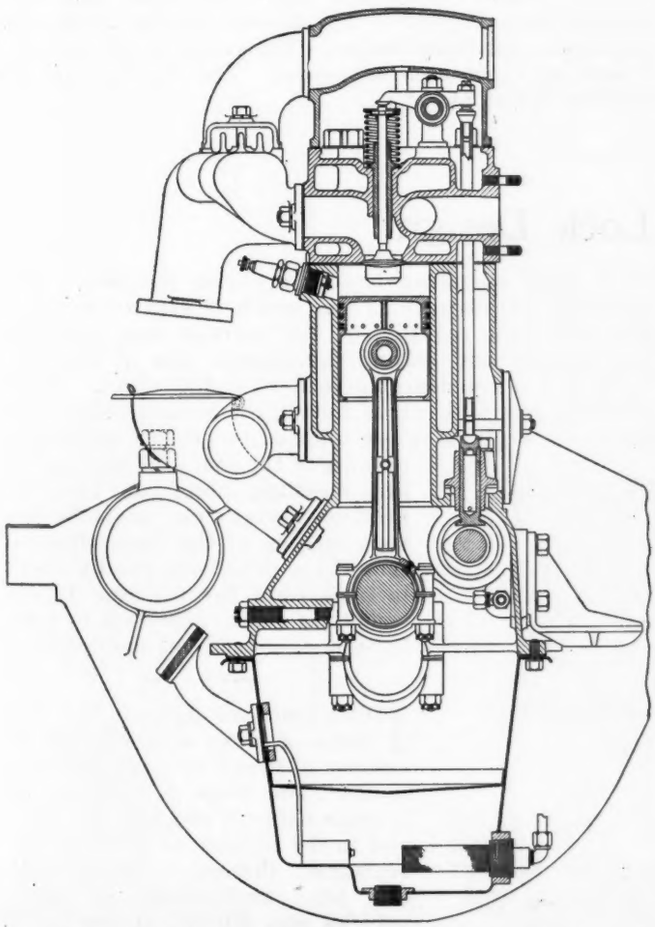
shaft lubricates the rocker arm bearings and the overflow oils the pushrods and valve lifters on its way back to the sump in the crankcase. Some of the overflow is caught in the shallow tray in the valve lifter chamber, and oil ducts drilled in the casting carry this oil to each of the four camshaft bearings. An oil pressure relief adjusting valve is located on the outside of the crankcase at the right front corner. The oil allowed to escape by this relief is discharged directly onto the crankshaft gear and thrown over the other gears, a portion of it being caught in a pocket over the generator drive shaft bearings and fed into these bearings through suitable passages.

The crankshaft is drop forged from S. A. E. No. 1045, 40-50 carbon steel, suitably heat treated. The camshaft is made from S. A. E. No. 1020, 15-25 carbon steel, case hardened on the cams and bearing surfaces.

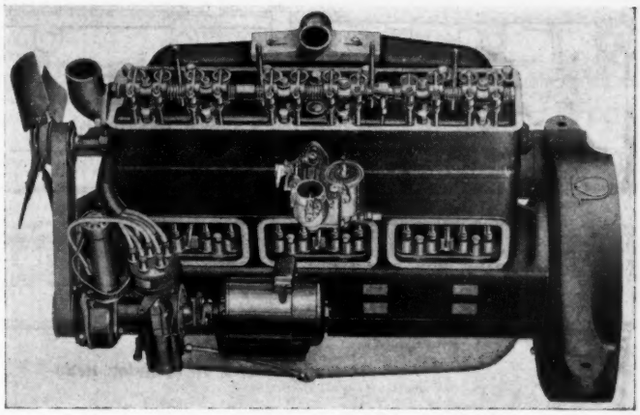
Camshaft and generator shaft bearings are die cast babbitt. There are four crankshaft bearings of 2 in. diameter and lengths from front to back as follows: 2¼, 1½, 1½ and 2¾ in. The camshaft is 1⅛ minimum diameter and has bearings which measure as follows: 1 5/16 x 2 9/32, 1 29/32 x 1, 1⅞ x 1 and 1 27/32 x 1¾ in. The makers state that the bearing areas are greater than for any other passenger car engine of equal displacement.

The connecting rods measure 8⅛ in. center to center. Connecting rod bearings are fastened in place and then expanded to completely fill the rod ends and caps. The bearings are broached after they are bolted together and are finally run in under tension. The length of the big end bearings is 1⅝ in. and the diameter 2 in.

The cast iron pistons are unusually light and are provided with three rings, all above the piston pin. The pistons are 3½ in. long and are given 0.001 in. clearance per inch of cylinder diameter.



Transverse section of engine showing valve and manifold arrangement



Inlet side of the new Velie six-cylinder engine

The cylinder block is a good example of thorough water jacketing, as is shown by the sectional views. The water jackets completely surround each cylinder as well as each valve seat. The block is first rough bored and then set aside for a time to season. A second boring operation is performed and then the bores are accurately ground to size.

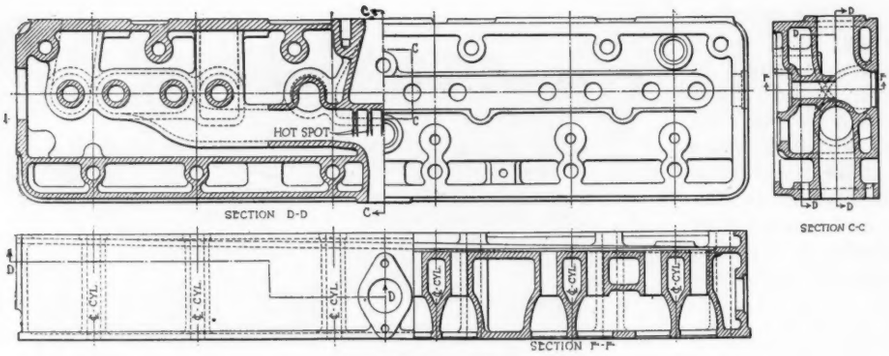
The piston pins are .740 in. diameter. They are held in the piston bosses by setscrews passing entirely through the pin and into the opposite wall of the boss. The rings are of cast iron and are 3/16 in. wide.

The removable cylinder head is held down by thirteen nickel steel studs. The rocker shaft is anchored to the head independent of the cylinder head studs and can be removed as a unit with the head. The time of the service operation of grinding the valves is considerably lessened by this constructon.

The valve stem guides are 3¼ in. long and are reamed by hand to accommodate the 5/16 in. valve stems. The valve lifters are hollow and are of the mushroom type. A cushion of oil is constantly present in the valve lifter and pushrod cup joint, and the usual noise incident to the action of overhead valves is thereby greatly decreased. The valve lifter assemblies can be taken out through the inspection plate holes after removal of two cap screws for each assembly. The timing is as follows: intake opens 7 deg. past top center, intake closes 47 deg. past bottom center; exhaust opens 45 deg. before lower center and closes 5 deg. past upper center. The clear lift is 5/16 in., the tappet clearance is 0.004 in., warm. The valve cover is an aluminum casting. The warm air for the carbureter flows through a passage in this casting. The fitting on the carbureter which takes the heated air from the exhaust stove has manually operated butterfly valve for controlling the admission of cold air.

The engine accessory drive is well worked out. The generator can be removed without disturbing the ignition unit, or vice versa. The exhaust side of the engine presents a clean appearance. A breather and filling spout of unusual size is mounted on the crankcase on this side. The starter is readily removed by loosening the retaining screw and locknut. The electrical units include Atwater Kent ignition, Bijur two-unit six-volt starting motor and lighting generator. The amount of oil in the oilpan, which has a capacity of 5 qts., is indicated by a gage on the exhaust side of the engine. S. A. E. standards have been followed throughout in the construction of engine and chassis. The flywheel housing is an S. A. E. No. 3.

The flywheel is machined to accommodate the Dooley clutch. A sectional view of this clutch is shown in one



Sectional views of cylinder head

of the cuts. This is a Velie product and is novel in two respects. First, the method of adjustment, which is accomplished without the aid of tools. The thumb nut shown in the drawing is movable and is positioned by notches on the clutch housing, similar to a notched throttle quadrant. It is necessary only to pull the thumb nut up and over one notch to secure the desired adjustment. The operating mechanism is carried on the clutch housing. The second feature is the method of securing the pressure plate. The usual practice in single plate clutches is to have this member driven by dowels fastened to the flywheel. A system of toggles provides for positive withdrawal of the clutch plate from the friction plate when declutching and also takes the drive.

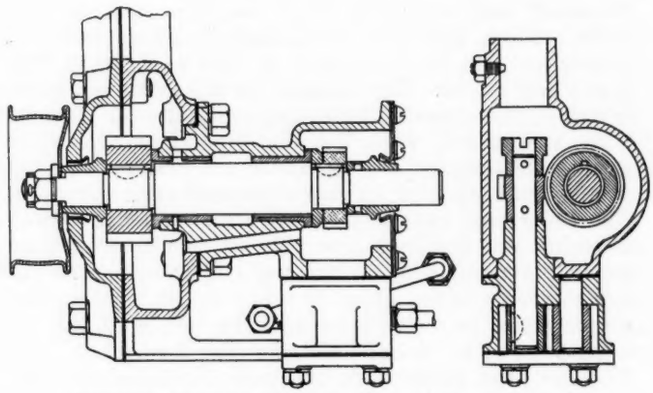
A Durston three-speed transmission is bolted to the housing behind the clutch. The main shaft is mounted on annular ball bearings and the countershaft is carried on plain bearings.

The powerplant is suspended at three points. The maximum speed of the engine is 3100 r.p.m., but a maximum of 45 hp. is obtained at 2500 r.p.m. The maximum torque is 115 lb. ft.

The frame is manufactured in the Velie shops. Semi-elliptic springs are fitted front and rear. The purchaser has the option of wood or disk wheels. The tire equipment is Miller cords 32 in. x 4 in. non-skid on all wheels. The rear axle is the latest model Timken, semi-floating. The pinion shaft is fitted with two bearings, one in front of the pinion and the other at the rear to insure a rigid pinion shaft.

Brakes are on the rear wheels. The hand brake is internal expanding and the foot brake external contracting.

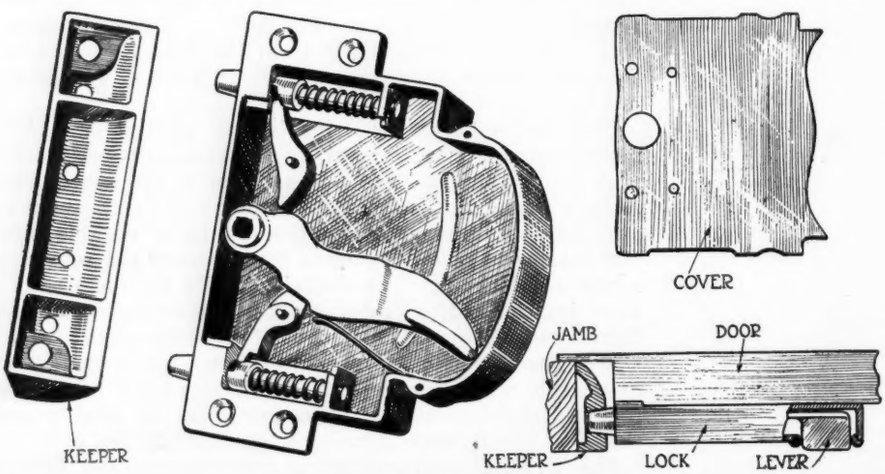
The Velie bodies are provided with genuine leather upholstery, and body lines are more rounded than formerly. The chassis will be fitted with both open and closed bodies. The prices on the inclosed models have not been announced. The touring car and roadster list at $1,395.



Sectional views of generator drive shaft and oil pump

A New Door Lock Design

AN automobile door lock with two tapered bolts is manufactured by Carl Mack and distributed by M. Eberhart & Son Co., Inc. The latch bolts have double guides in the frame of the lock. Their rear end is reduced in diameter and the bolts are forced into tapered keeper holes by coiled wire springs surrounding the reduced portion and bearing against a shoulder on the bolt. A flush lever operating handle operates the lock. The operating pressure is 22 oz., which is said to be much less than that required by the average door lock. In the opening and closing movements, one of the lock bolts has a considerable lead over the other. There are three operating parts moving the locking bolts. The double lock plungers are claimed to prevent accidental opening of the door and personal injury resulting therefrom. The compression springs on the bolts prevent rattling of the door. Elimination of the projecting handle makes it impossible for clothing to get caught in same. The lock is made in both right- and left-hand models.



New lock showing operating parts

IOWA leads all states in the total value of farm products and in number of motor cars registered on farms. The State is third in the average value of products per farm and in the number of motor trucks registered thereon. During 1921, the total registration of motor vehicles was 430,003, or one car to 7.31 persons.

Exports of Automobiles, Tires and Motorcycles for November, 1921

COUNTRIES	COMMERCIAL				PASSENGER				Parts	TIRES			All Other Tires	MOTOR-CYCLES	
	Complete Cars		Chassis		Complete Cars		Chassis			Casings	Inner Tubes	Solid Tires			
Europe															
Azores, etc., Islands					1	$350	1	$300							
Belgium	25	$10,928	18	$6,012	39	27,791	10	4,371	$3,111	$535	$39			10	$2,860
Bulgaria									62						
Denmark					13	17,375			91,963	23,399	1,295		$549	1	300
Finland									1,559	426	674	457			
France	1	1,240			4	9,800			8,350	13,445	495				
Gibraltar									26						
Greece	8	3,556			34	15,986			5,476	37,420	4,063		32	1	650
Jugoslavia									2,606	1,490	373				
Iceland and Faroe Islands					2	2,500			299						
Italy									3,068					25	7,909
Malta, etc., Islands					1	383			1,036	3,469					
Netherlands	29	12,675			21	24,416	1	1,000	27,071	16,623	955	203		29	7,565
Norway			1	1,576					5,336	6,566	828	1,300			
Poland and Danzig					1	700			4,717						
Portugal									8,126	4,598	28			1	350
Roumania									6,295						
Spain					5	4,911	1	375	15,538	15,122	2,567	7,795		100	30,444
Sweden	3	2,29?	2	2,280	81	83,208	2	1,456	12,816	49,337	3,156			2	517
Switzerland					8	11,366			3,467	6,211	526		113		
Turkey in Europe					4	5,162			687	1,238	147				
England			11	11,349	54	70,471	61	27,957	573,668	648,739	47,966	13,414		34	8,434
Scotland									781						
Ireland					1	385			7,322	700	80				
North and South America															
Bermuda											64		16		
British Honduras					2	2,025			295	300	185		14		
Canada	21	35,592	22	38,509	180	235,883	12	11,808	651,649	5,034	4,395	5,950	228	12	5,933
Costa Rica									778	314	15		30		
Guatemala					10	12,735			3,714	3,166	120				
Honduras			2	625	1	372			1,699	1,348	60	837	14		
Nicaragua									202						
Panama	1	437			28	26,842	1	1,250	3,175	16,076	994	1,461	1,727	1	350
Salvador	1	3,166			9	2,218			1,315	3,273	369				
Mexico	69	38,809	26	20,424	424	331,063	15	7,399	116,950	154,971	13,076	4,851	2,750	3	1,086
Newfoundland, etc.									454						
Barbados					6	3,730			1,594	2,629	163		97		
Jamaica	3	2,694	3	1,887	32	21,704	1	728	9,483	14,781	1,419	3,848			
Trinidad, etc.	11	6,387			17	7,336			3,239	7,195	419	248	44		
Other British West Indies	2	818			9	9,297			1,432	894	70		141		
Cuba	7	2,923			33	43,727			132,116	55,968	3,238	2,891	1,708	6	1,545
Virgin Islands									582	910	22	2,000	421		
Dutch West Indies					6	2,415			686	1,192	165		43		
French West Indies									1,353	5,879	313	771			
Haiti	1	437			11	9,238			2,947	4,484	865		203		
Dominican Republic	1	3,000			3	1,683			6,253	11,161	1,909	308	160		
Argentina	1	5,221	1	3,600	67	54,744			558,262	48,366	1,800	2,958		3	1,003
Bolivia										990					
Brazil	1	5,150			19	10,672			9,352	4,403	60	1,009			
Chile	2	4,286	2	5,207	2	1,801			4,840	5,886	941		531		
Colombia					15	10,751	4	1,890	11,007	7,239	452			1	300
Ecuador									1,264	5,856	506				
British Guiana					3	2,424			3,329	838	20	190			
Dutch Guiana									464						
Paraguay										96	3				
Peru							2	920	11,543	11,816	394	173	75		
Uruguay			10	2,990	2	3,000			12,084	12,295					
Venezuela					20	14,611			5,639	9,426	1,641	256			
Asia															
Aden									136						
Armenia, etc.					12	4,519									
China			4	3,012	2	3,500	1	1,520	3,657	6,032	668	327		2	375
Kwantung					1	1,107				106					
Chosen									3,000						
British India	1	1,164	1	1,116	68	62,537			24,814	3,625	2,943	11,271	72	5	1,775
Straits Settlements									3,300	4,334	836	2,891			
Other British East Indies					10	7,294			2,036	1,534				1	530
Dutch East Indies					5	6,250			1,250	1,200		2,100			
French Indo China									833	196					
Greece in Asia									846	3,146	120	137			
Hejaz, Arabia, etc.									1,487	1,876					
Hongkong					4	5,358			80	658				1	200
Japan	2	7,310	50	21,500	19	27,927			32,137	20,399	1,248	6,819	28	60	15,878
Palestine and Syria					63	27,673			1,540	9,909	1,725		1,200		
Persia										1,048					
Siam					6	3,972			292	466		73			
Australia	6	11,503	37	42,590	45	55,208	340	272,624	33,754	11,266	439	4,883		176	49,119
New Zealand			1	300	85	93,414			21,403	71,353	4,016	3,090		12	3,600
Other British Oceania					4	4,848			1,355	200	28		135		
French Oceania									1,851	1,333	189	836	249		
Other Oceania									1,279	105			73		
Philippine Islands	17	12,670	1	1,985	15	19,825			5,002	47,153	3,350	4,596	4,905	1	150
Africa															
Belgian Kongo			5	2,185					6,400					3	660
British West Africa	9	17,024	1	1,194	5	4,200	2	2,779	17,072	11,742	960			1	275
British South Africa					76	73,610			23,457	37,268	1,577	468	50		
British East Africa					1	1,857			1,143	4,548	442				
Canary Islands	3	1,311	3	3,959	11	12,945			3,839	1,933					
French Africa									2,345	110					
Morocco					6	5,732			7,100						
Egypt					10	4,292	5	1,670	3,916	6,412				6	1,989
Portuguese Africa	1	1,500												3	899
Spanish Africa															
Total	226	$192,094	201	$172,300	1,616	$1,509,143	459	$338,047	$2,546,424	$1,474,056	$115,411	$88,211	$15,608	500	$144,696

Distributors or Factory Branches?

Part I

Here is a fundamental discussion of this vital question. Present day practices are the result of rapid developments. The pressure from now on will be on the merchandising rather than the production phase of the industry. Later articles will continue the discussion of this important problem.

By Harry Tipper

THE present method of distributing the passenger car did not arise wholly out of the economic necessities as they exist in the fully developed business of to-day. In fact, the economic necessities of the present-day business are themselves entirely different from those necessities facing the manufacturer in the early days of the history of the automotive industry. As in other lines of business growing rapidly into their place in the social or industrial fabric, the distribution of the product was carried out along the lines of least resistance and in response partly to the pressure from the potential market outside the manufacturer's establishment, and only partly from the manufacturer's conceptions as to the advisability. There was little or no necessity for the manufacturer to study the economics of distribution in those days, because the unsatisfied virgin market was waiting for the passenger car to come within reach and exerted a constant pressure upon the manufacturer to improve the vehicle itself and to enlarge his production possibilities so that the vehicle itself would be available to them.

This was the great time for the engineer and the production man, as the future of the business depended almost entirely upon their work. The automobile is the only product of modern industrial times that has fixed the public's attention upon itself at all moments of its use. Every automobile running in the streets or roads was a spur of so effective a nature to the potential desire of those who did not own an automobile that the pressure of the market was very quickly felt as soon as the car became sufficiently reliable and produced in sufficient quantities to meet the demands of any section of the population.

As a consequence, manufacturers distributed the cars according to the pressure of the market, and the distribution system itself grew out of the market pressure until, as the business enlarged, it assumed the proportion existing to-day.

In the experimental era of the automotive business, when the production of cars was counted in single units, and the sale of cars was similarly counted, the man who sold cars for any individual manufacturer went into the business from his interest in the product. He was interested in the development of the automobile. Almost unconsciously he was dragged into the development of this new business by the character of his enthusiasm in the possibilities of the product. At this stage there were no distributors as they exist to-day. There were some few retail establishments selling automobiles, keeping them in order and keeping the salesrooms where the machines could be inspected. The men who sold cars in those days had to acquire sufficient knowledge to rescue them from their innumerable troubles and, in the course of that experience, they practically discovered a great many things not yet a part of the manufacturer's equipment of knowledge. By force of circumstances they became experts in the business, and the relation existing at that time is indicated by the fact that many of those distributors went into the manufacturing business later, while some of those in the manufacturing business went into the distribution field as the business developed.

As the automobile passed from the experimental stage and became available to a larger section of the virgin market, these dealers found it possible to sell a larger and larger number of cars. They received calls and inquiries for cars from the bicycle repair shops and other places in smaller communities in the trading area, and they began to develop into distributors, bringing those establishments in smaller communities into existence as dealers. Of course, this was not so in all individual cases. In the establishment of a new business like this there was a great deal of flux and change going on in all the individual territories as they opened up, and in individual cases. People came into this business in the retail end and in all branches from all kinds of business and professional work because of their interest in the product. They were able to establish themselves with comparatively little money. A number of those who were enthusiastic about the automobile projected themselves into the business, exerting their pressure upon the manufacturers and the older distributors who were included in the chain of distributing and merchandising the product itself. Naturally, these enthusiasts possessed an influence with the other members in their communities who were potential buyers of the product and a part of the virgin market. In those days the man who could own and successfully drive a car and keep it in shape was a man who possessed a considerable amount of knowledge in the eyes, at least, of those who had not yet summoned up sufficient courage to avail themselves of the possibility.

Thus, in one way or another, partly because of the human reactions in the case, partly because of the rapid growth of the business and partly because of the extent of the virgin market, there has grown up a system of distribution comprising distributors, those who secure the cars from the manufacturers and who wholesale those cars to retailers, doing at the same time a retail business of their own; dealers who are doing a retail business in a restricted territory, and branches of the manufacturing establishments developed in large centers to meet the possibilities of those centers as markets.

It was obvious in the early stages of the business that the man who went into the selling and maintaining of an automobile would be obliged to confine his interests to one individual car or one or two non-competing cars,

and the exclusive territory became a concomitant of this interest. Furthermore, the demand upon the dealer and distributor to maintain the cars in condition to perform their service was more insistent in the early days than it was in the later growth, because of the more or less experimental character of the product for a number of years and the constant development of weaknesses here and there in the building of production to its present proportions. As the product became stabilized, this necessity for service of the right character diminished somewhat in proportion and was partially overlooked.

It is necessary to consider the place of the various elements of distribution in the development of the passenger car market and its maintenance, to what extent they are fulfilling their functions, and the changes which must take place in order to meet the new requirements. In this examination the merchandising of the car must be expressed in its true relation to the maintenance of the car when it has been bought. The sale of an automobile is not concluded with the purchase of the machine, like the sale of a suit of clothes. It is purchased for service. The appearance of the car, its continued appearance, its reliability, the day-in-and-day-out efficiency for service, the amount of time which must be spent in repair and adjustment—are all elements in the sale of more and more importance as the virgin market is absorbed and the replacement market becomes a larger element of the future consideration. All the elements of distribution, therefore, must be considered from effectiveness in both developments and their functions determined for service as well as merchandising.

MANUFACTURERS who contemplate the establishment of factory branches to take the place of their regular distributors should approach the question with great care. The efficiency of such branches has a tendency to decrease in proportion to the centralization of their control.

The present elements are (1) the factory branch; (2) the distributor; (3) the retailer; (4) the repair shop, which does no merchandising.

The factory branch functions entirely as a distributing point of a wholesale character, controlled by the manufacturer. It is not in any sense a factory branch from the standpoint of production unless cars are assembled at that point. It is altogether a warehouse point receiving the complete product and redistributing it to the retailers or other elements in the distribution chain. The term "factory branch" is a misnomer, therefore, except as it refers to the financial control. It is really a distributing organization controlled by the factory, and it must function in this respect with an average efficiency equal to that provided by the independent competition. In other words, a factory sales branch, so called, must be able to pay its rent, its interest on the investment on its fixed charges, its sales work, its accounting, its warehousing and handling, and all the other elements which enter into the sale of the car for the same discount which would be allowed to the distributor of the same product were he an independent business man operating in that way.

The distributor of an automobile functions to the advantage of the factory in three ways:

1—By providing an orderly basis of production because of his ability to obligate himself for a large number of cars on a regular contract.

2—As a sales organization capable of exercising a more intensive contact with the retailers and of maintaining a better sales condition.

3—As a central service organization, capable of executing complicated repairs and adjustments with a definite standard of efficiency and price, and capable of seeing that the dealers are established to conduct the service for their more restricted areas.

The retailer functions with the automobile manufacturer because of the following advantages:

1—The ability to obligate himself for a definite number of cars over a definite period and to permit the factory to continue its future work with less speculation.

2—The ability to place the car conveniently for buying in a naturally restricted area adjacent to the trading center and to intensively operate sales work there.

3—The ability to make reasonable repairs and adjustments, keeping the car in service with less consumption of time and upon a decent basis of efficiency in the operations and the charges.

The exclusive repair shop, while it does not function as a part of the merchandising chain, is involved in the distribution of the car because of its ability to serve different makes of cars, particularly those models at present out of production; its influence in the choice of cars, and its contact with the users of cars make it a functional part of the chain of marketing in this field.

These several distributing functions must be performed for the manufacturer of cars, either by distributing depots financially controlled by the manufacturer or by independent organizations established for that purpose. The question as between those operations financially controlled by the manufacturer and those controlled by independent concerns is one of relative efficiency and cost entirely.

Bearing in mind that the marketing cost has a tendency to increase in proportion to the area covered from a single manufacturing unit, and the intensity of the competition in its group, the question of establishing factory branches should be approached with great care because the efficiency of such branches has a tendency to decrease in proportion to centralization of control.

It is quite natural in the rapid growth of a business like the automotive business, supplying a virgin market with a manufacturing capacity unequal to its demand, until this last year, that the distribution system should show a great variation. The distribution system has grown with the same rapidity as the production of automobiles and has had a very high mortality rate, as in all new lines of business. Comparatively few dealers, distributors, repair shops or storage points have secured a long experience in the business, and the variation in their individual efficiency is naturally very great. This variation is not due to the weaknesses in the system or the fact that it does not function economically, but is more largely due to the conditions of its growth and the rapidity with which the business has expanded. It would be impossible for this business to present an orderly system of distribution, a fair standard of general efficiency or a fair degree of understanding as to its problems through all the elements of its distributing area, when the business has grown from almost nothing to a five thousand million dollar distributing proposition in twenty years.

Manufacturers should avoid any hasty conclusions as to the deficiency in the system or any hasty decisions to change the present system of distribution under which they are working without a careful examination of the functions and purposes, because the difficulties are almost altogether elements of the growth and not functional disorders.

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Using Standards

FOR many years past the National Automobile Chamber of Commerce and more recently other similar organizations have assisted in bearing the expense of the excellent standardization work carried on by the Society of Automotive Engineers, but so far as we recall the trade organizations have done but little of moment to encourage the use of standards by the concerns represented in their membership. We are now pleased to note that efforts are being made to bring the advantages which accrue to manufacturers who use standards to the notice of executives in the industry. A recent N. A. C. C. bulletin, for example, is devoted to this subject. It points out, among other things of importance, that standardization has reduced production costs some 30 per cent in the case of ball bearing and electrical equipment manufacturers and 20 per cent in the case of steel manufacturers. Actual savings by the use of standards are difficult to determine in precise figures, but they are evidently very much worth while, as we have often pointed out.

In spite of this fact we frequently hear of some new car being fitted with non-standard parts for which there appears to be no excuse whatever and which often mean trouble and expense for some other manufacturer—an expense which the user must ultimately bear. Thus, for example, we learn that a certain new car has an exhaust pipe which is an odd and non-standard size (⅛-in. larger or smaller would have made it standard). Either the engineer who laid down the design or his draftsman didn't know of the existing standard or didn't bother to look it up. Or perhaps he thought it concerned nobody else.

But now comes the exhaust heater manufacturer and complains that he must make, and his agents stock, special sizes of fittings in order to accommodate his heater to the new model. Doubtless the muffler manufacturer had a similar story to tell, and so it goes. It sometimes happens that a non-standard size of part saves the car manufacturer a little money in the first instance, but if the part is one that may require replacement, it is likely to add to the parts stock which must be carried by many service stations and thus result in added expense for service, which reacts unfavorably upon the manufacturer. The user's interest must not be forgotten, especially when in so doing the matter of service, which is already a sore point, is unnecessarily complicated.

This is but one example of many in which standardization plays a part. Another way in which standardization may aid in the future will be in the increasing of used car values. At the present time the most valuable used car is the one which is the most easily serviced, all other things considered, and standardization should have an important bearing in this respect.

Number of Cylinders and Repair Costs

WHEN, a few years ago, the question as to how many cylinders a passenger car engine should have was being discussed there were many who predicted that the greater number of cylinders and other parts in the eights and twelves would mean much larger repair bills, when overhauling became necessary. Advocates of the multi-cylinder job, however, maintained that less frequent overhauling would be required, but this is open to some question if it is assumed that an equal quality of workmanship and material is used in the first instance.

Some further light is thrown on the subject as a result of repair shop experience. *Motor Age*, in a recent issue, publishes a table giving the fixed prices charged by a Chicago shop for certain repair operations on thirty well known cars, not including Fords. One of these operations, overhauling the engine, includes grinding of valves, removing carbon, adjusting tappets, refitting bearings, overhauling all accessories including starter and generator, cleaning entire engine and furnishing the following: new rings, new plugs, new radiator hose and new oil. In the list are included seven cars with four-cylinder engines, twenty with sixes, two with eights and one with a twelve. Presumably the price for this job is based upon cost. In any case, the price for over-

hauling in each class, including necessary parts and material, is as follows:

Number of Cylinders	Charge for overhauling Maximum	Mimimum	Average	Av'age charge per cylinder
Four	$72.80	$47.60	$54.41	$13.60
Six	87.50	59.00	69.17	11.53
Eight	112.00	99.00	105.50	13.19
Twelve	167.00	167.00	167.00	13.92

There are, of course, some qualifications necessary in the comparison. The eights and twelves are in the high priced class while among the fours and sixes are a preponderance of moderate price cars, though both these classes include also a fair proportion of cars selling in the same price class as the eights and twelves. The average charge per cylinder, it will be noted, does not vary greatly, although the cost of overhauling the accessories must be nearly the same in all cases. This is another way of saying that the average cost of overhauling an engine is roughly proportional to the number of cylinders.

Getting Facts

THE relation between car design and sales has always been recognized as important, but only recently have definite attempts been made to find out just what that relation is in particular cases. The buyers' market which obtains at present has tended to shift design out of the realm of pure engineering and into that of merchandising. The difficulty has been a lack of specific facts or data upon which to base procedure, and the only way to obtain such facts under present conditions is to go out and get them.

It is interesting to note that one of the largest car manufacturing companies has recognized the need for marketing data of this kind and has, consequently, prepared a comprehensive questionnaire, to be answered by all of its salesmen, designed to find out exactly what design characteristics are desirable from a sales angle. The questionnaire asks the salesman to outline the general specifications of the car he would build if he were to design a car of the class made by this manufacturer. It asks for suggestions regarding improvement in the present model; whether a yearly change in models is desirable from a sales standpoint; what criticisms of the present car owners usually make; the desirability of the permanent top as standard equipment; what accessories should be included as standard equipment; what type of body is desirable.

When the replies to these questions come in from salesmen in all parts of the country the results will furnish valuable data for use in design work. Such factors should always be considered by the engineer as well as by the general executive.

The consensus of these salesmen should not be allowed, of course, to dictate design in any sense, but their point of view should be given definite consideration. From a standpoint of automotive progress, however, nothing could be more detrimental in the long run than to have cars designed by the sales department. A search for facts upon which to base plans, nevertheless, is always desirable and the tendency to accumulate such facts and to use them intelligently is one of the gratifying outgrowths of the recent business depression.

Aids to Starting

MUCH remains to be done in the way of making cars easier to start in cold weather. More attention was given to this factor when hand cranking was the rule, but it has in general been overlooked or given inadequate consideration on a majority of modern cars fitted with electrical starters. As a result there is a great burden placed upon the battery and much trouble resulting from the effect of fuel which passes the pistons and dilutes the lubricating oil.

Experiments recently carried out by one manufacturer who was seeking to remedy troubles of this kind are reported to have shown that thirty seconds of cranking with the carbureter strangler closed resulted in a half pint of fuel flowing by the pistons into the crankcase. Four cranking periods of this length per day would thus result not only in wasting a quart of fuel, but in serious dilution of the lubricating oil with its consequent difficulties. This may be an exceptional case, but it is indicative of a very prevalent trouble which may be less or greater in degree in other cases. A large percentage of all cars are kept in unheated garages or are allowed to stand out of doors for long periods during which the engine becomes cold, and even in warm weather there is frequent difficulty in starting, for the initial boiling point or the proportion of light ends in the fuel is usually less in warm weather. Consequently the problem of obtaining a quicker start as well as that of so controlling the cooling system as to bring the engine up to a good operating temperature quickly is worthy of careful study.

The heat necessary for actual vaporization of the fuel needed in starting is sometimes obtained by the use of an electric heating element and sometimes by burning a small amount of fuel. Primers using fuel which is easily vaporized even at quite low temperatures have also been employed with satisfaction in some instances. Probably all devices or systems used to aid in starting have certain drawbacks as well as certain advantages, but the need for a simple, dependable and inexpensive device for this purpose is becoming increasingly evident and seems likely to become more necessary than ever as motor fuel is made less and less volatile.

Automotive Industries Index

THE index for Volume 45 of AUTOMOTIVE INDUSTRIES, comprising the last half of 1921, will be off the press in the near future. We will be glad to send a copy of this index to any subscriber who may have use for it. Those who received the index last year are still on our list and will receive this year's index automatically.

If you want a copy of this index, just send us your name so that we can mail one to you promptly.

Price Situation Again Befogs Air

Uncertainty Brings Show Buying to End

Early Impression Fades as Prospects Question Bottom Being Reached

By JAMES DALTON

NEW YORK, Jan. 17.—The first half of the New York automobile show indicated that the volume of sales at retail would be comparable to that of 1919, but buying stopped the last three days. It was due to another striking demonstration of "mass psychology."

After the show opened with an almost general revision of prices, the public evidently was almost persuaded that prices had reached rock bottom or practically that level. "Live" prospects were many and actual sales were frequent. Then along came one of the large production companies with the announcement to its dealers that its prices would be reduced Feb. 1, retroactive to Jan. 1, but that the size of the cut would be kept a secret.

After that news became generally known buying stopped dead, both at the show and in the Broadway salesrooms of companies in similar price classes. People went to the show just the same and evinced a lively interest in the models displayed but they did not buy. When asked their views they stated almost unanimously that they would wait "for the rest of the price cuts."

Second Cut May Come

Whereas the atmosphere within the industry had been cleared by the early days of the show, it again became foggy. Factory executives thoroughly familiar with the production costs of their own and other companies had been certain prices had been stabilized. They are not so certain now and prospective buyers have decided to wait and see what happens.

Several companies which did not announce reductions for the New York show undoubtedly will do so before the opening of the Chicago show on Jan. 28 or coincident with it. Whether second cuts will be made by those who already have made concessions remains to be seen.

Certain it is, however, that prices on popular priced lines cannot go much lower if the makers of them are to remain in business, no matter how large their production. The industry as a whole is praying that there will not be a price war, but individuals in the manufacturing division seem to be making mental reservations.

Manufacturers declare with every evidence of meaning what they say that they simply cannot make their prices any lower, for if they do they might as well go out of business. Even if they are making mental reservations in what they say, their statement undoubtedly is true if they manufacture cars in the lower price classes.

Economic laws will govern the situation. As a consequence prospective purchasers of motor cars in these classes will not be going far wrong if they buy now. They will find eventually one of two conditions. Either the car they bought will be selling for little less than it is to-day, or they will have an "orphan" on their hands.

Chicago Bank Buys Assets of Allen Motors for $570,000

COLUMBUS, Jan. 18—Judge Sater in the Federal Court has approved the sale for $570,000 of the assets of the Allen Motor Co. to Frank Shaw of Chicago, representing the Continental-Commercial Bank, the sale including all assets excepting cash in bank and notes receivable. Included are the plants at Columbus and Bucyrus, together with all finished cars, partly finished cars and raw materials. The Bucyrus plant was the motor manufacturing concern. Shaw expects to operate the company, making automobiles, but has not announced detailed plans.

With the bills and notes receivable estimated at close to $100,000, including cash on hands, there will be between $650,000 and $670,000 for distribution to the company's creditors. The claims not counting many of the contingent liabilities filed with the receivers are in excess of $2,000,000. Contingent liabilities will bring the amount much higher, leaving about 15 cents on the dollar to be distributed to creditors. Stockholders will get nothing.

PORTER PRODUCTION SOLD

NEW YORK, Jan. 16.—It is stated that George Van Tuyl, receiver of the American & British Manufacturing Corp. has sold to the F. S. Pearson Engineering Corp. of 115 Broadway, the entire Porter automobile product in stock and the entire future production of Porter automobiles.

Waiting Attitude Adopted by Public

New York Show Sees Buyers Bewildered—Must Be Convinced of Stabilization

By NEAL G. ADAIR
Editor Motor World

NEW YORK, Jan. 14—Since the New York automobile show opened its doors 29 manufacturers have reduced the prices of their passenger cars. During two weeks previous to the show 20 others made price cuts. This makes 49 producers, out of 92 exhibiting at the show, who have brought their prices down to a new level in such sensational fashion that prices, rather than new cars, are the talk of the show and the talk of the town.

After this statement it hardly seems necessary to say that the show which closed tonight was not a satisfactory selling show.

As compared with some of the larger dealer shows, New York never has been a strong selling show. It has served more to introduce the season's cars, both to the trade and to the public, and to give the show season around the country a flying start. However, there have always been some sales, and there are some this year, but the big harvest of the show is in deferred business. How long this business will be deferred depends entirely on the ability of the industry to convince the public that prices have been stabilized.

A Series of Reductions

Speaking bluntly, the public is bewildered. It has seen price cut after price cut made over a period of 15 months and just at the present moment it is not inclined to take anybody's word that the present cuts are final, even for a reasonable period.

What the industry does the next month is going to tell the tale, both of the business at the dealer shows and of spring business.

Throughout the first two or three days of the show there was an encouraging amount of actual order placing. This continued while news of the earliest first two or three price cuts was slowly sinking into public thought regarding the show. After several days of full page, half-page and quarter-page announce-

(*Continued on page* 150)

Lincoln Plan Rouses Keen Interest

Ford Will Use Own Production Methods

Expected to Make Big Price Reduction If His Bid Is Accepted

NEW YORK, Jan. 17—Nothing in recent years has caused greater interest and wider speculation within the automotive industry than the announcement that Henry Ford and his family probably will obtain control of the Lincoln Motor Co. when it is sold by the Detroit Trust Co., as receiver, on Feb. 4. The bid of $8,000,000 filed with the Federal Court by Harold H. Emmons as attorney, came from the Ford family, including Mr. and Mrs. Henry Ford and Edsel Ford.

No Opposition Expected

The offer of $8,000,000 was the upset price fixed by Judge Tuttle, and it is stated the Fords are willing to raise their offer to $11,000,000 rather than have the property get into other hands. It is not believed, however, that they will have any serious opposition.

If the property goes for $8,000,000 it will fall short by $2,000,000 of meeting the liabilities, which approximate $10,000,000. There are outstanding 146,000 shares of Class A stock of $50 par value, which would get nothing from a sale at that price.

The industry is not so much interested in the financial details of the transaction as in what use the Fords will make of the property if they get it, and there seems little doubt that they will. No details of their plans have been made public, but it is not denied that they will put into effect the well known Ford production methods.

Prices May Be Reduced

Purchases of parts and materials, it is understood, will be made through the Ford purchasing department and the result, with the introduction of efficiency methods in production, would be much lower costs, which would make possible a sharp reduction in prices. Reports that these would be scaled down to $2,500 for the touring car have not been denied, although there is no probability that any such cut will be made immediately. The effect of such a policy upon other companies in the higher price classes needs no discussion.

It is not the Ford plan, so far as can be determined, to lower materially the quality of the Lincoln car. It is generally conceded, however, that a car of practically the same quality can be turned out in much larger quantities at a materially lower cost by the elimination of construction refinements and tests which have been insisted upon hitherto by Henry M. Leland, the founder of the company.

The Lincoln plant, which is considered the finest of its kind in the world, has a potential capacity of 20,000 cars a year. Comparatively few changes will be necessary to put the plant on a Ford production basis, and Ford engineers have been working on this problem for several months.

While he does not intend to sacrifice quality, it is believed Ford intends to bring into the manufacture of the Lincoln the same production and management methods which have made his cheap car such a success. Nothing radical is contemplated and it is not expected any material changes will be made in the immediate future. Preparations have been made to proceed with production as soon as Ford takes over control of the property. It can be stated that the present line of cars, which numbers 15 models, will be continued.

The belief that Ford will have little competition in seeking to purchase the property is based largely upon emphatic denials by other leaders in the industry

(*Continued on page* 152)

E. V. Rippingille Joins Watson Stabilator Forces

DETROIT, Jan. 16—E. V. Rippingille, assistant sales manager for Hudson and Essex for a number of years and particularly interested in sales promotion and service work for these concerns, has resigned to handle the Watson Stabilator throughout the Michigan zone.

Rippingille is particularly known for his many sales promotion efforts, particularly in organizing and carrying through to a successful finish the Hudson and Essex transcontinental records and other record runs both on the road and track with these two cars. He has been associated with the industry abroad as well as in this country almost since its inception and recently has been devoting his efforts to the organization and establishment of the Hudson-Essex service policy.

The Watson stabilator is a shock absorbing device counteracting spring rebound by means of an internal brake arrangement so designed as to graduate the resistance in proportion to the severity of the impact. It has been installed through local dealers on a great many cars throughout the East and is now under tests by manufacturers, one of the first cars definitely to adopt it being the new Duesenberg.

Show Attendance Shatters Records

More Dealers Come from West—Public Interest in Automobiles Evident

NEW YORK, Jan. 16—From the standpoint of attendance, the New York automobile show which closed Saturday night was the most successful ever held in the United States. All records for paid attendance were shattered, contrary to expectations. The increase over last year was approximately 20 per cent and it was much in excess of 1920, which was the best previous year.

The attendance Thursday was the largest for any single day in the history of automobile shows. It was 4106 greater than Thursday last year and 2210 ahead of the best previous day on record.

Another record which was broken was the attendance of dealers from the West. In previous years dealers from Chicago have come on for the show, but the representation from other western cities, such as Kansas City and St. Louis, has been small. The reverse was true this year.

Bankers Enthusiastic

Manufacturers who attended the exposition were enthusiastic over the conclusive demonstration of public interest in automobiles. They would have been satisfied if the attendance had been no larger than last year and all of them were amazed at the number of New Yorkers who paid their money to get into the show.

Bankers interested in the automotive industry were equally enthusiastic over this feature of the exposition. They are more firmly convinced than ever that the motor vehicle has become an absolute essential in the life of the country and that it should be regarded by them hereafter in that light.

In fact, the show was a great success from every standpoint except that of sales. The first three days were entirely satisfactory in this respect but the slump in the last three after the announcement by Dodge Brothers of the deferred price cut proved conclusively that the public expects further concessions.

McGRAW ELECTS DIRECTORS

EAST PALESTINE, OHIO, Jan. 16.—Stockholders of the McGraw Tire & Rubber Co. have elected the following directors for the coming year: John Morgan, William H. Marlatt, C. H. Wheeler, L. M. Kyes, Maynard H. Murch, W. S. Quinlan, G. E. Randles, R. V. Mitchell, Mac S. Bethel, F. W. Treadway and Ben H. Davis.

Refinancing Plan Offered for Earl

New Issue of Debentures Contemplated—Creditors' Committee to Guide Company

CHICAGO, Jan. 13—Following a day and night meeting of the banking and merchandise creditors of the Earl Motors, Inc., a plan for the refinancing and rehabilitation of the $8,000,000 corporation, which was the outgrowth of the old Briscoe Motor Co., was agreed upon last night. The reorganization of the company was made necessary by the troubles of the Fort Dearborn banks and Edward Tilden & Co., which had undertaken to finance the company.

The reorganization, it is said, will place Earl Motors in fine shape financially, but the stockholders will have to depend largely upon the future success of the company for their equity in the concern. The business will be continued with the present staff of officials, but under the guidance of a creditors' committee.

Banks to Furnish Capital

At present, Earl Motors has unsecured indebtedness in excess of $3,000,000. It has outstanding $2,100,000 of debenture bonds, $1,500,000 of preferred stock and about 291,000 shares of common stock of $10 par value. The debentures and 91,000 shares of common represented the holdings of Edward Tilden & Co.

While the plan of settlement agreed upon will undoubtedly go through, the final formula for stock issue is not absolutely settled.

The financial reorganization contemplates a new issue of deferred debentures, on which interest will be deferred for a year, and a new issue of prior preference preferred stock. The unsecured creditors would be given these debentures and the new stock in satisfaction of their claim.

Edward Tilden & Co. is to surrender the present debentures, receiving in exchange $1,400,000 of prior preference preferred stock and $700,000 in new debentures. The creditors may receive debentures and stock in equal proportions. The banks are to furnish the company with $1,000,000 or more for working capital.

Will Be Long Term Maturities

The new debentures will probably be long-term maturities, whereas the present securities mature $500,000 each year. This plan, which was agreed to by creditors representing claims of $2,000,000, will enable the company to retire the debentures without payment of interest on the new ones for a year and will also enable the payment of all current liabilities.

The creditors' committee named to carry out the plans consists of Ralph Van Vechten, vice-president of the Continental-Commercial Bank, Chicago; Percy Johnston, president of the Chemical National Bank, New York; R. T. Forces, vice-president of the Fort Dearborn Bank, Chicago; William Sparks, president of Sparks-Withington Co., Jackson, Mich.; Benjamin Gotfredson, president of the American Auto Trim Co., Detroit; W. V. C. Jackson, vice-president Auto Body Co., Lansing, and Charles Hayes, president of Hayes Wheel Co.

Grants Extension of Time for Kelley Reorganization

NEW HAVEN, CONN., Jan. 14—Dating from Jan. 9, following a petition by Attorney Edward D. Newman of New York, who seeks to form a new corporation to take over the Kelley Tire & Rubber Co. of this city and West Haven, Judge John E. Keeler in the superior court has granted a 45-day extension of time for the reorganization.

To permit the transaction, $350,000 will have to be raised before the time limit expires. With the additional period in which to raise this amount, Attorney Albert H. Barclay of this city, receiver for the company, says that the prospects for securing the money are encouraging.

According to figures submitted by Newman, approximately $50,000 worth of bonds have been sold up to Jan. 9.

The money is needed, it is pointed out by the receiver, to pay off the debts and expenses of the receivership of the Kelley Tire & Rubber Co. and of the Martin Tire & Rubber Co.

Newman's proposal is to form a new corporation, which will buy the plant and equipment, and thus save at least part of the investment of the present stockholders. It is estimated that about 20 or 25 per cent of the total number of Kelley tire shares are held in Hartford and vicinity.

Goodyear Tire Sells Plant on Long Island

NEW YORK, Jan. 16.—The Goodyear Tire & Rubber Co. has sold its land and buildings in Long Island City to the Standard Sanitary Mfg. Co., of New York and Pittsburgh. The transaction involves approximately $500,000. The property consists of a six story fireproof building having 63,000 sq. ft. of floor space and about 69,000 sq. ft. of vacant land adjoining with a railroad siding.

After the Goodyear company abandoned the building it was leased by the Chevrolet Motor Co. for a term of 10 years.

COTTA INCORPORATES

ROCKFORD, ILL., Jan. 14—The reorganized Cotta Transmission Co., manufacturer of parts for motor vehicles, has been incorporated with a capital stock of $750,000. The new company takes over the plant of the old and will operate along similar lines, but with new officers and directors. The new name will be Cotta Transmission Corp.

Court Considering Miniger Contract

Ohio Bank Asks Continuance of Agreement Which Provides His Salary

TOLEDO Jan. 16.—There is a possibility that Clement O. Miniger, president of the Electric Auto-Lite Corp., and one of the receivers for the Willys Corp., may not remain as head of the company if the federal court refuses to allow a continuance of the agreement entered by him and the corporation, Jan. 25, 1919.

This agreement makes his salary approximately $240,000 a year.

The Ohio Savings Bank & Trust Co., the complainant in the receivership proceedings, has moved the court to continue the salary and commission arrangement under which Miniger is working. The bank points out that depriving the company of Miniger's services would mean a loss to the stockholders and creditors through possible loss of much business now being done outside the Willys-Overland accounts.

Under the agreement Miniger was to receive $60,000 annually, and 20 per cent of the net profits on sales, except Willys-Overland sales. It was stipulated that the commissions should not exceed $150,000 a year for the first year beginning Jan. 1, 1919, and not exceeding $190,000 the second year beginning Jan. 1, 1920. He was to have a drawing account of $15,000 a month but this was not to exceed the commissions for any one month.

Miniger Inspects Property

NEW YORK, Jan. 16—C. O. Miniger, receiver for the Willys Corp., has returned to Toledo after an inspection of the company in New York and New Jersey. The plants of the New Process Gear Corp. at Syracuse and the Electric Auto-Lite Corp. at Toledo are running on a satisfactory basis.

The big problem of the receivership is to dispose of the so-called Chrysler plant at Elizabeth in which the Chrysler six was to be built but which never went into production. It is understood that an effort is being made to induce the bank interests which are large creditors of the Willys Corp. to form a company which would take over the Elizabeth plant and manufacture the Chrysler car in it. These negotiations have not yet passed the preliminary stage.

REORGANIZING ADKINS COMPANY

CANTON, OHIO, Jan. 16—Reorganizing and refinancing of the Adkins Manufacturing Co. is now under way, the company already having taken over the assets of the Adkins Sales Manufacturing Co.

The company manufactures a high pressure lubricating system, aimed at obviating the use of grease cups on automobiles, trucks and tractors.

Ford Joins Parade with Cut in Prices

Reductions Range from $6 to $15 —Made Advisable by Persistent Rumors

DETROIT, Jan. 16—Price cuts ranging from $6 on the runabout to $15 on the sedan are announced by the Ford Motor Co. A statement made in connection with the announcement says:

"Persistent rumors relative to our reducing prices make reduction advisable, despite present rock bottom prices."

The Ford prices as they stood in January, 1921, with the successive reductions since that time follow:

Model	Jan. 1921	June 1921	Sept. 1921	Jan. 1922
2-passenger ..	$395	$370	$325	$319
5-passenger ..	440	415	355	348
Coupe	745	695	595	580
Sedan	795	760	660	645

The passenger chassis will sell for $285; the truck chassis for $430, a reduction of $15; the tractor will remain at $625. The starter price stands at $70 and the demountable rims at $25.

A statement on 1921 business issued by the Ford company says:

Ford Sales Exceeded 1921

Retail sales of Ford cars, trucks, and Fordson tractors have again exceeded the million mark for the year 1921.

The Ford factory and assembly plant production figures reached a total of 1,050,740 cars, trucks and tractors for the year, with retail sales by dealers approximately 1,093,000 which in the United States alone surpassed the 1920 retail sales record by 104,213 Ford cars and trucks.

The outlook for 1922 is decidedly optimistic. In fact, concrete evidences already exist in that car and truck retail sales for December 1921 exceeded December 1920 sales by almost 25 per cent, and Fordson tractor retail sales for the same periods show an increase of over 100 per cent for December 1921, as well as an increase over the total tractor sales for the month of November.

These facts seem to indicate that not only are the farmers buying more freely, but that the general public is becoming more responsive and receptive.

Another point brought out by a comparison of production figures for the past two years shows that Ford enclosed cars are gaining in popularity, as 23 per cent of the 1921 production were sedans and coupés as against a total of 18 per cent for the year previous.

Ford is giving employment at present to approximately 40,000 men in its main plant at Detroit, the importance of which is emphasized when consideration is given to the fact that nearly 20 per cent of the city's population is directly dependent upon the Ford Motor Co.

Performs Service to Industry

NEW YORK, Jan. 16—For once in his life Henry Ford has done what other automobile manufacturers admit is a service to the industry. They believe his most recent price cut of $7 on the touring car and $15 on the closed models will do more than anything else to convince the public that automobile prices are down as far as they can go.

Other manufacturers say it is evident that even Ford, with his tremendous production, has reached the point where he can reduce prices no further and still make a profit on each vehicle. Most of them contend they are in the same position. It undoubtedly is true that most manufacturers in the lower price classes cannot do much more cutting if they expect to remain in business.

While Ford is being thanked, unofficially, for his latest reduction, companies making cars in the higher price classes are waiting with genuine anxiety to see what will be done with the Lincoln car if Ford gets control of that company. They are inclined to take seriously reports that the price of the Lincoln will be reduced to something like $2,500 with Ford methods applied to bring about quantity production. If this is done competition in the higher price classes will be fully as keen as among cars selling for $1,000 or less.

Durant and Columbia Prices Are Guaranteed

NEW YORK, Jan. 16.—Durant prices were guaranteed to the dealers until Aug. 1, 1922, and Columbia to April 1 by representatives of the factories producing those cars at a meeting luncheon of fifty-five dealers of the Poertner Motor Car Co., Metropolitan distributor.

The Durant announcement was made by M. B. Leahy, General Sales Manager of the Durant Motor Car Co., of New York. In view of the recent announcement of a proposed price reduction by another manufacturer in the Durant price class, the Durant guarantee was regarded as significant.

Leahy told the dealers that the Long Island plant was running on a production of 85 a day and that the schedule soon would be increased to 100. He said the Long Island plant would continue to manufacture cars for the Pacific Coast territory until the plant in Oakland got into operation. Leahy also told the Metropolitan dealers that production of the new Durant Six would begin in about two weeks.

The announcement of the Columbia price guarantee was made by Colonel William Guy Wall, vice-president and chief engineer of the National Motor Car & Vehicle Corp. of Indianapolis.

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BESSEMER TO MOVE PLANT

PHILADELPHIA, Jan. 14—The Bessemer Motor Truck Co. is making final preparations to remove its headquarters to its new plant of Holmesburg, where the production of trucks will be undertaken on a large scale. The plant is situated on an 18-acre tract and the plant has a capacity of 3000 trucks a year, which will soon be absorbed if the company's plans develop in accordance with the predictions of the president, I. M. Lewis.

Low Price Basis Set for New Tire

Seiberling Clincher to Sell for $12.50—Straight Side for $44.50

AKRON, Jan. 14—The new cord tire invented by Frank A. Seiberling and to be manufactured ready for delivery at the Barberton, Ohio, and New Castle, Pa., tire plants, now controlled by the Seiberling Rubber Co. of Akron, will be placed on the market upon a price basis remarkably low, officials of Seiberling's company announce.

The main new structural feature of the Seiberling tire is the extension of the tread stock from bead to bead, replacing the fabric side walls and calculated to afford added protection against customary side wall abrasions and curb and rut wear.

The tire is also designed to reduce possibility of tread separation to a minimum. Among its other new features are added shoulder strength, and reinforced chafing strip and double flipper strip strength. The tire has a semi-flat tread which, it is claimed, will afford better traction through greater road contact area which will offer an added resistance to skidding.

New Tube to Be Produced

Although the Seiberling company announces it will place the new tire on the market as one of the best cord tires manufactured, its prices will range only slightly above standard cord prices of other companies. The consumer price on the 30 x 3½ Seiberling clincher cord tire will be $12.50, and the 34 x 4½ straight side will sell for $44.50.

The tires will be marketed under the standard tire guarantee of the Rubber Association of America.

Seiberling will also place on the market a new tube, which it is claimed will embody new features giving it greater durability. The new tube is made over a large size mandrel of pure gum floating stock, and is designed to reduce chafing and "set" to a minimum.

The Seiberling company will continue to manufacture the Portage Skidlock tread tires of the Portage Tire & Rubber Co. of Barberton, which Seiberling has purchased. The company will have a capacity of 5000 casings and 6000 tubes daily at its Barberton and New Castle plants.

Diamond Has New Tire

AKRON, Jan. 16—A new cord tire, said to possess unusual road gripping qualities and to offer special resistance to skidding, has been introduced by the Diamond Rubber Co. of Akron, according to announcement of H. E. Keller, sales manager.

The new feature of the tire is said to be the fact that its road gripping qualities will last throughout the entire life of the tread.

Studebaker Head Sees 100,000 Year

Company Closes Most Successful Period With No Bank Indebtedness

NEW YORK, Jan. 13—Expectations of a 100,000 Studebaker year were expressed by President A. R. Erskine to 500 distributors and dealers gathered at a dinner in the Hotel Plaza last night. Erskine stated that the schedule for the first quarter would be 25,000 as against 11,000 for the last quarter of 1921. Total production for last year he told them was 68,000 and for the year previous 54,000. The company has $36,000,000 invested in its factories.

H. A. Biggs, vice-president in charge of sales, acted as toastmaster. Addresses were made by M. F. Wollering, vice-president in charge of production; L. J. Ollier, vice-president in charge of exports, and Frank E. Hering of South Bend. The dinner was the occasion of the maiden speech of Harry B. Harper since joining the Studebaker organization in the capacity of sales manager.

Corporation in Good Condition

NEW YORK, Jan. 14—Studebaker on Dec. 31 last closed the most successful year in its history and while final figures have not been announced, it is said that the gross for the year will approximate $95,000,000. The company has on hand more than $8,000,000 in cash and has no bank indebtedness. A year ago the cash account stood a little more than $4,000,000 and the bank indebtedness was $8,500,000.

Probably the largest individual holder of common stock is W. C. Durant, formerly head of General Motors Corp. and now president of Durant Motors, his holdings, it is understood, approximating 65,000 shares, representing an investment of between $4,500,000 and $5,500,000.

Six Companies Produce 84 Per Cent of Total Cars

NEW YORK, Jan. 16—Discussing the production of passenger automobiles, the *Wall Street Journal* says:

There are upward of 100 active passenger automobile manufacturers in the United States and six of them (considering the half dozen General Motors divisions as one unit) account for more than 80 per cent of the cars produced. Last year approximately 1,535,000 passenger cars were turned out. Ford, General Motors, Dodge Brothers, Studebaker, Willys-Overland and Nash produced nearly 1,300,000, or about 84 per cent of the total. Ford's output of something like 875,000 passenger cars was more than half the combined turnout of all manufacturers.

Following tabulation for 1921 and 1920 shows total passenger car output, individual outputs of the six companies mentioned, their total and per cent of grand total made by them. Figures for 1921 are approximated:

	1921	1920
Total passenger car output	1,535,000	1,883,150
Output of:		
Ford	875,000	*885,000
General Motors	192,000	327,681
Dodge Brothers	89,350	129,624
Studebaker	66,000	52,653
Willys-Overland	51,300	104,569
Nash	23,600	34,634
Total six companies	1,297,250	1,534,161
Per cent of grand total made by six companies	84 per cent	81 per cent

*Approximately

Jewett Unveiled to Dealers; Price Announced as $1,065

NEW YORK, Jan. 13—A large number of Paige-Detroit dealers enthusiastically received the new Jewett six which was unveiled at their annual banquet last night. President H. M. Jewett of the Paige company who was the speaker of the evening announced that the price of the new car would be $1,065.

Jewett confined his remarks largely to the opportunity for the motor car dealer in 1922 and spread an atmosphere of optimism throughout the meeting. He declared the day of making big allowances on used cars to promote sales had passed and that henceforth only the soundest of business tactics would be employed. The financial condition of the Paige-Detroit Motor Car Co., he declared, is sound.

There was no announcement as to how many of the new Jewett sixes had been contracted for but the dealers were not slow in expressing their enthusiasm during the meeting.

Developing Organization for New Franklin Product

SYRACUSE, Jan. 16.—The H. H. Franklin Manufacturing Co., expects to be producing its new 4-cylinder model at the rate of 100 a day by April, 1923.

Just now the organization for the development of the new model is being worked out. Ralph Murphy, assistant to John Wilkinson, designer of the Franklin engine, is in charge of the organization development. He is being assisted by R. G. Scott, R. P. Lay, J. L. Yarian, Roscoe Tennant, F. J. Ludwick, Allie Morris and Joseph Babcock. Other changes made in preparation for the new car include the selection of William Lane as assistant production manager, George W. Scott as plant engineer, and Charles Dewald in charge of the factory cost department.

"The outstanding features of the new $1,000 Franklin Four," said H. H. Franklin, in discussing the car, "aside from its low price, will be its easy riding and handling, road ability, gasoline and tire economy and its air-cooling system. It will be a world-wide utility car.

"Merchandising of the car will extend to world markets, and means considerable expansion of dealerships in this country."

Nash Makes Profit of $2,226,078 in Year

Company's Surplus Nov. 30 Stood at $13,418,094; Liquid Assets, $14,476,768

KENOSHA, WIS., Jan. 16.—A net profit of $2,226,078 for the fiscal year closed Nov 30, is shown by the Nash Motors Co., after deducting all expenses, reserves, inventory mark-downs and taxes. Allowing for dividend requirements $288,750 this is equivalent to approximately $35 a share on the 54,600 shares of common stock outstanding. In 1920 the company showed a net income of $7,007,471.

The balance sheet shows accounts payable of $520,164, as compared with cash on hand and in the bank of $13,275,966 and Liberty loan bonds amounting to $1,200,802. The company's surplus stood at $13,418,094 on Nov. 30. Real estate, plant and equipment are valued at $7,589,040 after charging off $2,551,686 for depreciation.

In his remarks to the stockholders President Charles W. Nash said in relation to prices:

"We feel now that the price situation is pretty well leveled out. The prices of automobiles have been reduced to near pre-war prices, and without doubt automobiles are being sold to-day at a smaller margin of profit than ever before since the inception of the industry. We are of the opinion that volume of sales for 1922 will not be extremely large, but we have a feeling that the business will run along in a more uniform manner, which makes a better manufacturing proposition."

Cleveland Companies Augment Plant Forces

CLEVELAND, Jan. 14—The Fisher-Ohio Body Co. business is operating at almost top speed. There are 2000 employed at present, but E. F. Fisher states that 1000 more will be added within the next three months. The plant is now engaged in making bodies for General Motors, Chandler and Cleveland.

The Chandler factory has doubled its factory force within the last three weeks. The number of employees is to be increased an additional one-third by Feb. 1. At the factory it was stated that in addition to men given employment at the company's plant, Chandler activities have within recent weeks put back on the payroll in subsidiary plants either controlled by the company or patronized by it an additional 2000 men. These are establishments in which accessories and parts are made.

The Cleveland company has been putting men to work recently, and the production has been augmented greatly. This company also is hiring more men and will continue that policy through the month and February.

Propose Bus Lines for All New York

City Administration Plan Would Mean Scrapping of All Surface Cars

NEW YORK, Jan. 14:—What probably is the most ambitious motor bus program ever proposed has been laid before the Board of Estimate by Mayor Hylan and Grover A. Whalen, Commissioner of Plants and Structures. Their proposal includes the scrapping of all the present surface car lines in the Borough of Manhattan and the substitution of 3,500 motor buses which, it is estimated, could carry 2,240,000 passengers a day.

$25,000,000 to Be Provided

The Board of Estimate has gone so far in approving the project as to adopt a resolution declaring against further elevated construction or rapid transit lines and expressing the opinion that future passenger transportation within the city should be by subways and buses.

Commissioner Whalen asked that $25,000,000 in corporate stock be set aside to carry out the program as soon as the city has obtained the legal power to establish a system of bus routes. The plan will be acted upon later by the board and then will be submitted to the state legislature for approval. Whalen estimated that the profit from the operation of 3,500 buses would be $4,031,000 a year for the city.

Whalen's request that the board set aside $25,000,000 for a bus system was addressed to the mayor. It read, in part, as follows:

Program Is Outlined

Pursuant to your directions, a comprehensive bus program has been worked out for the entire elimination in the Borough of Manhattan of the surface car tracks and the substitution therefor of a bus system. In the Boroughs of Brooklyn, Bronx and Queens a bus system has also been worked out to augment the trolley car system now in operation.

In the Borough of Manhattan at the present time there are operating in the neighborhood of 1,060 trolley cars. In the program outlined below, we have planned to substitute a bus seat for every trolley seat now operating in the Borough of Manhattan.

In order that this department may be properly equipped to meet its responsibilities to the public in the matter of passenger transportation, I respectfully recommend to your honorable board that corporate stock (revenue producing) be set aside in the amount of $25,000,000 for use as follows:

For the construction of 3,500 modern, well-built, sanitary, stable, safe and properly equipped motor buses, according to the plans perfected by the department	$19,250,000
For the purchase of spare parts and garage equipment	700,000
For the construction and equipment of a central motor bus repair shop	1,000,000
For the construction and equipment of garages	3,800,000
For contingencies	250,000
Total	25,000,000

While making this recommendation primarily in order to meet the transportation necessities of the public, and as a measure necessary to protect the vested interest of the people in the five cent fare, I am submitting this request also as a sound business proposition.

From the experience of this department in motor bus operation and from study of the transportation needs of the city, I believe that there is need for 200 bus lines in the Boroughs of Manhattan, the Bronx, Brooklyn and Queens, conditions in Richmond making the trackless trolley system better suited to the needs of that borough.

On these lines it is estimated that the traffic would average 2,240,000 passengers a day.

These passengers, at five cents each, would pay $112,000 a day, or $40,880,000 a year.

The fixed charges, including interest, depreciation and liability insurance, would amount to $9,089,000.

The administration and maintenance cost would be $4,400,000, making the total fixed charges $13,489,000.

Estimate Net Revenue, $4,031,000

The operating cost for an average of 3,200 buses in service would be $23,360,000, making a total cost-fixed charges plus operation $36,849,000, leaving a net revenue to the city amounting to $4,031,000.

Therefore, I trust that your honorable board will approve this recommendation whether viewing this proposition as a duty to the people who require transportation, or as an economic proposition attractive to the taxpayers, who require reduction of taxation.

Although the initial appropriation made for this purpose by your honorable board on March 12, 1920, is not available for the service of the people, owing to the injunction obtained by a traction bondholder, it is not to be seriously believed, that this impediment will remain indefinitely. Whether by reversal of the court ruling or by legislation, the city will no doubt come into the enjoyment of its fundamental right to serve the transportation needs of its people.

It seems, therefore, that in scheduling the corporate stock funds to be set apart

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Reimported Trucks Sold for 50 Per Cent List Price

LITTLE ROCK, Jan. 16—Tom Laser of the Laser Motor Co. recently arranged in New York to handle a number of motor trucks in Arkansas for the British Government. A few have already been sold in the State and will be used in road work by contractors.

They are new American-made trucks that were bought by the British Government in the closing days of the war, and were not needed. They were ordered sold at prices ranging from 40 to 50 per cent of the present list price on the same make of trucks. They include 5-ton Pierce-Arrows, 3½-ton Whites, 3-ton Rikers and 1-ton G. M. C's. The total number is said to be about 1600.

Bullard Machine to Make Cycles

Four Cylinder Machine, Equipped With Side Car, Planned by Company

BRIDGEPORT, CONN., Jan. 16 — Manufacture of motorcycles, on what is planned ultimately to be an extensive scale, has been inaugurated by the Bullard Machine Tool Co. of this city, for years one of the representative metal trades establishments of southern New England and during war days prominent in the production of munitions. During the past ten days the working force of the concern has been increased by 150 employees and more will be employed as the motorcycle department develops, according to an announcement by Stanley H. Bullard, vice-president of the concern.

The motorcycle to be manufactured is a four-cylinder machine, equipped with a side car. All parts are to be made and assembled at the Bullard plant and shipped to the selling agencies. The Bullard company, according to announcement, will merely manufacture the motorcycle and is not interested in the sales end of the business. The concern is now working on several contracts, including a large one from the firm of Sinclair & Militor of New York.

Bullard says that the manufacture of motorcycles is now confined to a part of the big plant building heretofore used for storage. "Of course, we anticipate that the motor department will grow," he said, "but there is ample room for the expansion. It will in no way hamper or interfere with our manufacture of machines and our general work."

Receiver Is Appointed for Stephens Companies

KANSAS CITY, Jan. 16—The A. J. Stephens Rubber Co. and the Stephens Stores Co. have been placed in the hands of receivers, for the purpose of reorganization to meet the demands for large recent expansion in business. The rubber company, organized in 1916, bought the Kansas City Tire & Rubber Co. plant in 1920, the controlling interest of which was purchased later by J. H. Phillips of Pottstown, Pa.

The Stephens Stores Co. was established about a year ago to market the product of the manufacturing company. It eventually operated about 14 stores, in various cities, expanding very rapidly, and doing a volume of business that has now required additional capital. R. C. Ford, its manager, has been made receiver for that company, and C. F. Wilhener was appointed receiver for the rubber company.

The receiverships were asked by Charles E. Gregory of Chicago. It is said both companies are solvent and that the receivers will work out a plan for reorganization.

Waiting Attitude Adopted by Public

New York Show Sees Buyers Bewildered—Must Be Convinced of Stabilization

(*Continued from page* 144)

ments in all the newspapers all featuring prices, the public began to see what was happening and prospective buyers, though evidently in the market for cars, became decidedly cagey and signed contracts were few and far between. The only thing that will convince them that stabilization is here is stabilization, with prices left alone, so that people who are thinking of buying cars can have time to exercise their sober judgment and come to a realization of the fact that prices, in the average case at least, have gone about as low as the manufacturer can bring them and still do business at a profit.

Dodge Affects Situation

There are some indications that the price avalanche has spent itself and that quotations on motor cars are going to remain stationary. This is a big note of encouragement in the New York show and for the many shows in large and small cities all over the country which are to follow.

The Dodge Brothers announcement of a reduced price is retroactive to Jan. 1, but with the new prices withheld from buyers as well as prospects until Feb 1, it had a startling effect on the entire show situation. It sent people to the Dodge Brothers exhibit in a vain effort to learn what the prices would be, but it did not start them buying cars. New reports of another Ford reduction also were a disturbing factor.

Dodge Brothers' dealers, who were in town in great numbers from almost all parts of the country, say they did not expect any immediate stimulation of sales, but look for it when the prices become known Feb. 1, and possibly even a few days before. And prospects did not besiege alone the Dodge Brothers exhibit for Dodge price information. They went around the show asking salesmen in other booths if they knew what the prices would be, how they would compare with other prices, and numerous other questions hatched by fertile imaginations.

Some Sales Good

Naturally there were all kinds of guesses as to what the new Dodge quotations would be, but the public seemed to have remembered that the last advertised "substantial reduction" amounted to $300 and that another substantial reduction from the present price probably would be proportionate.

The Dodge advertising seemed to form a sort of climax to the public reaction to upwards of half a hundred cuts, and when mid-week came there was noticed a decided slowing up in sales and a decided increase in the "We'll-wait-awhile-and-see-what-happens" attitude of prospective buyers.

Several New York distributors of well established cars whose prices have not been changed recently, or who made their reductions before the show, gave confidential figures which indicate that a few lines, at least, were running far ahead of last year in actual sales. Some others were doing immediate business on a par with that done at last year's show, and there were several whose sales records at the end of the week were ahead of those of any New York show except the dealers' show held in 1919, a few months after the signing of the armistice. On the other hand, several distributors frankly stated that the annual show business was considerably below last year's record.

But the metropolitan distributors, and distributors and dealers who were here from different States, had their thoughts centered on the prospects for late winter and spring business rather than on the show week sales, and there was much to encourage them in this respect. All through the show exhibitors were getting long lists of bona fide prospects. Far fewer fictitious names and addresses were given than last year and far more appointments were made for later interviews or demonstrations.

More people than the most optimistic show boosters hoped for came to the show with the intention of preparing themselves to buy. A majority of them plainly were not satisfied that the time was quite ripe, as far as prices are concerned, but they are on the lists as active prospects, and it was difficult to find in the show, or about town anywhere, progressive merchants handling popular, or at least fairly well established lines,

(*Continued on next page*)

Portage Trustee Sues Under Bankruptcy Order

AKRON, OHIO, Jan. 18.—George D. Bates of Akron as trustee of the bankrupt Portage Rubber Co., of Barberton, has filed suit against the Rubber City Clearing House of Akron and A. H. Noah, its president, for $136,153 under order of the bankruptcy courts. The Portage Rubber Co. was the parent concern of the Portage Tire & Rubber Co., recently purchased by the new Seiberling Rubber Co.

According to Bates an agreement was reached between Noah and the Portage Rubber Co. in November, 1919, whereby the Rubber City Clearing House was to purchase all the "second" tires to be manufactured by the Portage Tire & Rubber Co. during the ensuing year. Bates claims several car loads of tires were delivered to the Clearing House but were rejected. He specifies the sum of $163,153 as representing the loss sustained and as being the difference between the price to have been paid by the Clearing House, and the ultimate price for which the tires had to be sold.

Kelly-Springfield Names Sales Force

Prepares for Intensive Drive in Anticipation of Big Truck Business Year

SPRINGFIELD, OHIO, Jan. 16—Severing its sales connection with Hare's Motors, the Kelly-Springfield Motor Truck Co. is organizing its own sales force and is preparing for a big increase in business during 1922.

General Manager E. O. McDonnell announces that the company's sales organization is about completed. A number of the branch managers and district representatives have been in Springfield for the past few days preparing for the intensive sales drive planned.

Personnel of Organization

The following sales representatives have been appointed:

Middle West, Pearl A. Lewis, Springfield, Ohio; South, P. W. Maguire, headquarters at Atlanta; Pacific coast and district manager, Clifford N. Snow, formerly of the Selden Motor Truck Co., headquarters at San Francisco; Eastern district, J. W. Dyson, formerly in charge of the sales department of the Link Belt Co., headquarters at New York City; New England district and branch manager at Boston, P. S. Aultman, headquarters at Boston; district branch manager for Illinois, Western Michigan, Minnesota and Wisconsin, A. H. Gibbons, headquarters at Chicago; district branch manager for Kansas, Iowa, Missouri, Oklahoma, North and South Dakota, B. J. Saunders, headquarters at Kansas City.

Aultman, Gibbons, Saunders and Lewis have been with the Kelly organization for a number of years. Maguire was formerly with Hare's Motors as zone manager of the eastern half of the United States with headquarters in New York City. Several years ago he was treasurer of the Kelly-Springfield company with headquarters in Springfield.

The present organization includes Charles W. Young, member of the banking firm of Emerson McMillin & Co., and also of the American Light & Traction Co., who is president of the Kelly company; E. O. McDonnell, vice-president and general manager, formerly lieutenant commander in the United States Navy and later secretary and treasurer of the Mexican International Corp.; W. K. Jamison, factory manager, formerly production manager for the Delco Light Co. and P. H. Diehl, secretary and treasurer.

MAY TAX G. M. STOCK TRANSFER

NEW YORK, Jan. 16.—The General Motors Corp. declines to comment on reports that stockholders of the corporation who participated in the distribution of five shares of the Delaware company stock for one share of the New Jersey company in 1916 may have to pay a Federal tax on the stock received. It is understood the case will be tried in the Federal court.

Report Canadian Car Demand Good

Collections Slow and Used Product Situation Bad—General Conditions Improve

TORONTO, Jan. 16—Dealers and distributors are practically unanimous in reporting the new car demand good, collections slow and the used car situation execrable or a near impossibility. Almost without exception, the fall and winter to date have yielded much more business than a year ago and considerably more than anticipated.

Unemployment has been considerably reduced, a number of leading merchandising concerns in non-automotive lines including the largest department stores in Canada and even leading jewelry houses report business to be gratifyingly improving and to have enjoyed one of the best and, in a number of cases, the best Christmas trade in their histories.

Quebec Shows Gain

As yet complete registration returns for the Dominion for the past year are not available. Up to the end of October there were registered in Canada, according to provincial returns, 469,310 motor vehicles, an increase of 60,311 during the first ten months of the year. The 1920 increase was 85,639. Ontario's increase in the first ten months of 1921 was 30,000 against 44,600 in 1920.

Quebec, while making a far poorer showing compared with Ontario as well as in proportion to population relative to the preceding year, showed a gain in increment of approximately 40 per cent or an increase of 14,807. The Western provinces' annual increase sagged badly, Alberta making the poorest showing with a nominal increase of 250 motor vehicles.

Ontario boasts roughly 45 per cent of the motor vehicles in the Dominion with a little better than a third of Canada's total population.

The figures quoted above and in the table are exclusive of the motor cars and trucks in the extra provincial parts of the Dominion, such as the Yukon, Northwest territories, Ungava, Labrador and Newfoundland.

	1919	1920	1921
Ont.	132,000	176,600	206,900
Sas.	54,750	59,708	62,958
Que.	34,987	44,900	59,707
Man.	29,163	36,322	40,430
Alta.	34,000	38,500	38,750
B. C.	19,500	28,000	31,000
N. S.	9,900	12,450	14,250
N. B.	8,061	11,101	13,564
P. E. I.	999	1,418	1,750
Total	323,360	408,999	469,310

Conditions in South Improving

NEW YORK, Jan. 16.—Conditions in the south are improving slowly but the improvement is substantial and promises to be lasting, in the opinion of Charles W. Tway of Atlanta, southern distributor for Haynes cars and vice-president of the Hanson Motor Co. Tway says:

I am convinced that sales of automobiles in southern states in the current year will exceed the total of 1921. Banking conditions show improvement, which is in contrast with the situation last year when difficulty was experienced by business men in obtaining adequate financial accommodations. That I have confidence in the future of the automobile industry in the south is evident from the fact that I have under construction a building at Atlanta to cost $200,000, which will be used largely by the Haynes Company.

Waiting Attitude Adopted by Public

(*Continued from preceding page*)

who did not confidently look for a satisfactory volume of early spring business.

Many prospects frankly said that they were still running the old cars they would have got rid of a year ago but for the uncertainty as to future business conditions which prevailed at that time. This year there was apparent in the show conversations confidence in the gradual but steady betterment of industry and commerce, and the old cars, these people said, are going to go and new ones take their places in their garages as soon as they feel satisfied that they can buy at a real low level of 1922 prices.

In the automotive equipment section of the show the prevailing spirit was in sharp contrast with the uneasiness evident on the passenger car floors. Automobile equipment prices, even if a few of them have dropped, do not get the wide publicity that attends a reduction in the passenger car field and the equipment manufacturers went on about their business, which was decidedly encouraging, throughout the entire week. A manufacturers' sales agent who distributed several lines made an interesting summary of the situation when he said that while motor car owners and jobbers showed no more interest this year than in former years in the accessory exhibits, dealers and garagemen, who were present in great numbers, made the most thorough canvass of the equipment section in the history of the New York show.

He expected this condition to be productive of results because the growth of the automotive equipment industry must depend not upon the inclination of car owners to buy, nor the urging of jobbers to sell, but on actual selling of them by the retail trade. It remains a fact, however, that the aisles in the automotive equipment sections were pretty well thronged throughout the week.

APPERSON MAKES OTHER CUTS

KOKOMO, IND., Jan. 14.—Additional reductions on three of its models have been made by the Apperson Bros. Automobile Co. The four-passenger sedanette has been reduced from $3,895 to $3,625; the seven-passenger sedan from $3,995 to $3,695 and the limousine from $4,195 to $3,895.

Stockholders Buy American Motors

Flat Sum of $200,000 Is Realized from Sale of Physical Assets

NEWARK, N. J., Jan. 18—Sale of the physical assets of the American Motors Corp. to a syndicate of stockholders was confirmed after a hearing before Judge Charles F. Lynch of the United States District Court. A flat sum of $200,000 was realized from the sale, which included production and service stores and the plant at Plainfield, N. J., other assets being retained by the receivers.

The sale was approved on the recommendation of a large majority of creditors. The property will be taken over by a new corporation to be known as the American Motors Corp. of New Jersey, which will continue the manufacture of the American line of cars substantially in their present form.

Company Reorganized

The reorganized company will have a capitalization of $500,000 of 8 per cent debenture stock, retirable at the rate of 10 per cent yearly beginning Jan. 1, 1925, and 50,000 shares of Class A (voting) common stock and the same number of shares of Class B (non-voting) common stock, each having a nominal par value and participating equally in earnings.

One half of the issue of debenture stock and the entire issue of Class B common stock will be taken up by stockholders of the present company.

Gramm Truck Prices Cut; Name Changed to "Pioneer"

LIMA, OHIO, Jan. 16—Price reductions are announced on the various models made by the Gramm-Bernstein Motor Truck Co. The list follows:

	Old Price	New Price
Model 10—1 ton	$1,365	$1,365
Model 15—1½ ton	2,050	1,900
Model 65—1½ ton	2,725	2,500
Model 20—2 ton	3,175	2,925
Model 30—3 ton		3,275
Model 75—3½ ton	4,375	4,225
Model 40—4 ton		3,975
Model 50—5 ton	5,275	4,895

The name of the line has been changed to the "Gramm Pioneer" instead of "Gramm-Bernstein."

RUGGLES CANADIAN PRICES

OTTAWA, ONT., Jan. 14—Ruggles 1-ton chassis are now being advertised at $1,585 f.o.b. London, Ont. Bodies and cabs are supplied at net extra cost when required and time payments arranged. Two-ton chassis are quoted at $2,285.

LAMPERT BILL PASSES HOUSE

WASHINGTON, Jan. 16—The Lampert Patent bill providing for increased salaries in the patent office has passed the House.

Lincoln-Ford Plan Arouses Interest

Latter Will Use Own Production Methods and May Decrease Price of Car

(*Continued from page* 145)

that they expected to bid for the property at the receiver's sale. Among those who have been reported as interested in the property, but who assert there is no basis for such statements, are the banking interests back of the Hupmobile and Mitchell; W. C. Durant and the Studebaker Corp.

If Ford is successful at the sale he will operate the Lincoln plant as a unit of the Ford Motor Co. The Lincoln car and the Lincoln company will retain their identity, however, and the management will be vested in Henry M. Leland and his son, Wilfred C. Leland, who operated the company before it went into the hands of the courts.

Stockholders' Interests Considered

Nothing definite can be stated at this time as to what will become of the investments of present stockholders. The Lelands stand to lose more than any other interest, but they have urged that some means be found to protect from complete loss the interest of legitimate investors who staked their money on the reputation of the elder Leland, who is regarded as one of the "grand old men of the automotive industry" and who is held in affectionate esteem by the Fords.

It is recalled that in the early days of the industry there was in Detroit a firm called Leland & Faulkner which ran a machine shop. Next door to this shop was a little repair shop conducted by Henry Ford in which he was trying to build an automobile. Ford had to give up his shop when he reached the end of his financial resources. It was taken over by Leland, who installed in it an engineer named Brush, who was given instructions to continue the development of an automobile. Brush kept at work and built a car which was called the Cadillac.

Ford Once Declined Help

Although he always has held the Lelands in high esteem, Ford was deaf for months to their appeal for assistance when it became apparent they would be unable to surmount the difficulties which confronted them after their plant finally went into production soon after the business depression really got under way. The negotiations with Ford were conducted by W. C. Leland. He had made his first appeal for assistance in June, 1921, but Ford declined to take on any new ventures at that time. He maintained this position in several subsequent interviews, but in November told Leland to return when he and his father had lost everything.

This admonition was kept in mind by Leland and he went back to Ford after the receivership. All the facts in the case were presented to Ford and he then agreed to take over the company if he could obtain it for what he considered a reasonable price. So far as can be determined, his only purpose was to aid the men who had devoted all their energies to the development of a highly respected enterprise and prevent its destruction. It is tacitly understood that the influence of Mrs. Ford and Edsel Ford was responsible for the decision of Ford to back his friends.

The views of Ford on the Lincoln situation are contained in this statement by him:

"It would be a stain against the motor car industry and against Detroit to permit outsiders to secure control of the Lincoln plant merely because the Lelands have been caught in a financial pinch. Henry M. Leland is one of the great motor car men of America."

BRISBANE SAYS FORD HAS A 2-TON TRUCK

NEW YORK, Jan. 17—Arthur Brisbane is the latest representative of the Hearst interests to obtain an interview with Henry Ford. He labels it "All About Ford" and sketches briefly his plans for the purchase of the Lincoln plant. The chief interest of the industry in the Brisbane report, however, is the statement that Ford pointed to a mechanical drawing with the statement:

"There's the two-ton truck. It will have the front end of my tractor, the engine and the rear end of the present Ford truck. See how much space we save by putting the driver close up in front."

Brisbane quotes Ford as saying the truck will be ready "perhaps next July."

Propose Bus Lines for All New York

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for public purposes it would be wise to make definite provisions for meeting this greatest of all civic needs—the need for adequate, safe and dependable passenger transportation.

While the present obstruction is being dissolved in the crucible, the time may be well spent in perfecting plans, routing, organizing and preparing for the prompt installation of motor bus service on the 200 routes which will be required to provide proper surface transportation to supplement and feed the city's vast underground system of rapid transit and to afford communication in the outlying sections of the city where vacant lots and fields await the homebuilder while the homeseeker is forced to remain in congested areas for lack of such transportation.

George McAneny, chairman of the Transit Commission, has stated that the resolution of the Board of Estimate with relation to future subway building was in accord with the commission's policy.

Daugherty Drafts Association Policy

Action Taken Earlier Than Contemplated—Public Announcement Expected Soon

WASHINGTON, Jan. 17 — It finally has been definitely determined by the Government to issue a statement regarding practices of open price associations. This proposal which originally had been planned and which trade associations have been urging with increasing persistence since the decision of the Supreme Court in the Hardwood case still is the subject of conference between Attorney General Daugherty, Secretary of Commerce Hoover and members of the Federal Trade Commission.

Attorney General Daugherty states that he has prepared a tentative draft outlining the attitude of the Government toward practices of trade associations with the expectation of making it public soon. This follows on the heels of the understanding that the Department of Justice had concluded not to issue the statement.

No Conflict with Law Suits

While the character of the statement to be given out is not known, it is believed that it will be scrupulously drafted so as not to cause any conflict with cases before courts or that may come before them bearing on trade association activities. It was stated by the attorney general that the Department of Justice will give its judgment to show how far such associations may go and to provide a guide for them as far as possible.

The department, it was declared, desires to encourage lawful associations both by reason of constructive work they may do for the trades they represent and through co-operation with the Department of Commerce.

Kentucky Wagon to Raise $500,000 New Capital

LOUISVILLE, KY., Jan. 16.—The Kentucky Wagon Mfg. Co., manufacturer of the Dixie Flyer probably will be reorganized with $500,000 additional capital, it was announced following a special meeting of the stockholders. No final action was taken as all details had not been worked out, but according to James R. Duffin, attorney for the company, the $500,000 additional capital will be raised.

Two schemes of reorganization were proposed. Under one of them the company would be merged with a number of automobile manufacturing concerns under the name of the Associated Motor Industries and the other proposition would place a mortgage of $750,000 on the plant of the Kentucky Wagon Mfg. Co., and the organization of a new company to be known as the Kentucky Mfg. Co., to which the real estate, machinery and equipment of the wagon company would be leased for a period of from five to ten years.

George B. Selden, Pioneer, Dies

Defeated by Ford in Patent Fight

Early Inventor Laid Claim to Conceiving Basic Principle of Automobile as Whole

ROCHESTER, N. Y., Jan. 17.—George Baldwin Selden, one of the first inventors of a gasoline propelled vehicle, and a large stockholder in the Selden Motor Truck Co., died here to-day after a brief illness. He had been in poor health for several years, but it was not until the last few weeks that his failing became marked. He was 75 years old and leaves his wife, Jean Shipley Selden; two daughters, Louise Selden Cary of New York City, and Clara Sayre Selden of San Diego, Cal.; two sons, Henry Rogers Selden and George B. Selden, Jr., both of Rochester, and three grandsons.

Claimed Basic Patent

Selden's name will stand out in automotive history chiefly through the long controversy which raged in the courts about his claim of a basic patent on the automobile as a whole, which affected practically every manufacturer of several decades ago and which finally terminated with an adverse decision directed against him and in favor of Henry Ford.

The Selden patent was first applied for on May 8, 1879, with the filing of a claim on a self propelled gasoline vehicle. The patent was not issued until Nov. 5, 1895.

The real start of the patent litigation was made in 1899, when the Columbia & Electric Vehicle Co. of New Jersey made a license agreement by which it secured the exclusive rights in Selden's patent. The following year this company was absorbed by the Electric Vehicle Co., and with it was acquired the Selden license agreement.

Sues Winton Company

The leap of this company to the front as the most powerful element in the automobile field was marked by the vigorous enforcement of the Selden patent and a complaint alleging infringement on the part of the Winton Motor Carriage Co. of Cleveland was drawn up and filed in July, 1900.

The patent was sustained in general terms by the United States District Court. The suit was carried along, taking testimony from 1900 until 1903, when a movement was instituted by George H. Day and others to form the Association of Licensed Automobile Manufacturers, with the Selden patent as its foundation. This was accomplished March 5, 1903, and the Winton company and nine others signed the agreement as charter members.

Under the agreement the licensed companies agreed to pay as royalty to the Electric Vehicle Co. 1¼ per cent of the retail list price of all cars sold by them and the company agreed to pay two-fifths of the sum to the A. L. A. M.

GEORGE B. SELDEN

Automobile veteran shown in car of his invention which was built in 1905 as an exhibit in the patent suit

As the popularity of the automobile increased the royalties became so large that they proved burdensome to the industry and long before the annual output of licensed cars passed the total of $100,000,000 a year a supplemental agreement had been reached under which only $150,000 annually was paid to the Electric Vehicle Co. and the remainder was placed in the general fund of the association. No public statement ever has been made with reference to the total royalties paid by the manufacturers on account of the Selden patent. It is probable that the inventor received all told not far from $200,000 gross.

The litigation between Selden and Ford is regarded as one of the most spectacular chapters of automobile history. The original suit was filed on Oct. 21, 1903, against C. A. Duerr & Co., New York agents of the Ford Motor Co. John Wanamaker, O. J. Gude and Panhard & Levassor later were made defendants. The action was brought at the request of the A. L. A. M. in the name of the Electric Vehicle Co. and Selden in the southern district of New York.

(*Continued on page* 154)

Headlight Makers Consider Grouping

Will Meet in Chicago to Decide Matters Pertaining to Organization

NEW YORK, Jan. 16—Manufacturers of headlight devices for automobiles have been invited to send representatives to a meeting which will be held in the Old Colony Club at the LaSalle Hotel, Chicago, Jan. 30, to decide whether to form a separate organization or to affiliate with the Motor and Accessory Manufacturers' Association as a group. Affiliation with the M. A. M. A. has been recommended by a committee which was appointed at a meeting of representatives of ten manufacturers held here.

Decision on the subject was deferred at that time because not all manufacturers invited to join in the movement were represented. Among the activities proposed either as a separate association or as a group of the M. A. M. A. is an educational and publicity campaign to teach public officials and the public generally something of the principles of headlight construction and adjustment as a means of promoting safety.

Wood Wheel Group Elects

Another proposition is that the manufacturers co-operate with the Society of Illuminating Engineers and the National Safety Council in an effort to obtain uniform state legislation in regard to headlights.

The chairman of the committee which is arranging the Chicago meeting is Fred H. Ford of the C. A. Shayler Co. at Waupun, Wis. Manufacturers who wish to send representatives to the meeting are urged to communicate with him.

The Wood Wheel Group of the M. A. M. A. which succeeded the Wood Wheel Manufacturers' Association, has elected the following officers:

Chairman, Thomas A. White, president of Crane & MacMahon, Inc., St. Mary's, Ohio; vice-chairman, C. F. Field, general sales manager of the Hayes Wheel Co., Jackson, Mich.; secretary and treasurer, Phineas Jones, general manager of Phineas Jones & Co., Newark, N. J. The executive committee is composed of the officers and S. Vance Lovenstein of the Schwarz Wheel Co., Philadelphia and A. E. Krick, vice-president of the National Dry Kiln Co. of Indianapolis.

The Leaf Spring Group of the M. A. M. A. is considering better methods of testing springs and spring metal with a view to establishing a uniform standard of tests throughout the industry.

George B. Selden, Pioneer, Is Dead

Figured for Years in Patent Litigation—Defeated in Court by Ford

(*Continued from page* 153)

There was an impressive array of legal talent on each side and never was a patent suit tried more exhaustively. The record of testimony made 36 large volumes and Judge Charles W. Hough declared in his opinion on the case that more than half of this testimony was utterly worthless. As a consequence of this suit the present simplified equity rules were laid down by the Supreme Court of the United States.

Hough Sustains Claim

The taking of testimony began after the complainants had proved the patent. In the meantime an automobile embodying the claims of the patent had been constructed to prove that it would run. Among the witnesses for the complainants was Dugald Clerk, a British engineer considered the highest authority on the gasoline engine. The defense called, among others, Charles E. Duryea, the Amercan pioneer. It is reported that when Duryea read a copy of the Selden patent soon after it was issued in 1895 he said: "Why, this patent covers only the Brayton type of motor." From the viewpoint of the highest court his opinion was correct although it was voiced 16 years before the court handed down its opinion.

The opinion of Judge Hough, rendered in September, 1909, sustained the patent in every particular; declared Selden the pioneer and granted the complainants an injunction and accounting. The result of this decision was to strengthen the A. L. A. M. but Ford soon took steps to protect the users of his cars by taking an appeal from the decision and depositing a bond to cover the damages of the complainants.

While the appeal was pending the Ford company laid the foundations for the tremendous increase in its business which has developed since that time.

Noyes Renders Opinion

The opinion of the Circuit Court of Appeals was written by Judge Noyes. He found that the patent had been held in the patent office for 16 years after application for it had been filed. He had ample evidence that the patent possessed novelty and invention but he also had evidence that the motor propelled road vehicle was not new and that the gasoline engine was not new.

The opinion of Judge Noyes, which was handed down during the National Automobile Show in New York in 1911, held that the patent was valid but that Ford did not infringe because the patent described an engine of the Brayton type while all the defendants and almost all the modern automobile makers used the engine of the Otto type to which Selden had referred contemptuously in his diary as "another of those damned Dutch engines." The complainants decided not to carry the case to the United States Supreme Court.

This decision removed the chief purpose of the A. L. A. M. which at that time included the makers of 90 per cent of American automobiles but there was no way for the members to withdraw during the life of the patent and it proved such a powerful constructive influence that it could not be abandoned. Out of the resulting situation and involving a merger with the National Association of Automobile Manufacturers there developed the National Automobile Board of Trade now known as the National Automobile Chamber of Commerce. The decision, however, put an end to Selden's royalties. If his patent had been sustained and he had continued to receive a gross royalty of one-fifth of one per cent on the cars made up to Nov. 5, 1912, which was the date upon which the patent would have expired, his receipts would have made him many times a millionaire.

Home City Loyal to Him

In spite of his gruffness and aloofness toward his neighbors, Selden always was warmly interested in his home city and in the automotive industry. In his later years, at least, Rochester has held that Selden should be given credit for conceiving the idea of the automobile as it has developed in America. It always has contended that he was entitled to the credit of having built the first "horseless carriage" used in this country in spite of the claims of the Appersons, Haynes and Duryea.

Selden first became interested in the idea of a self propelled vehicle for common roads when he was a boy. He heard his father and D. S. Morgan of Brockport, N. Y., a manufacturer of agricultural implements, discuss the subject and both of them believed that it would be impossible to use a road vehicle driven by its own power.

Later Selden entered Yale University. This was in 1865 and when he was at New Haven he tried to get some information on the subject from the college library. From that time on he conducted experiment after experiment and concocted device after device, all bearing directly or indirectly on the subject of a self-propelled vehicle. In 1869 he filed an application for a patent on a hard rubber tire, the first of the type now generally in use.

From that time on he worked away in his spare hours. His time was necessarily limited, because he was a patent attorney.

The real idea, Selden said, came to him in 1877, and in 1878 his three-cylinder engine was shown to a number of Rochester men.

LAMP COMPANY BANKRUPT

ROCHESTER, N. Y., Jan. 18 — The Denlinger Lamp & Ignition Co., Inc., of Syracuse has filed a petition in bankruptcy with liabilities of $21,169 and assets of $12,819.

Location of Motor Changed in Dirigible

Engines Will Be in Cockpit of Machine Being Assembled by Goodyear

AKRON, Jan. 14—Hangars of the Goodyear company at Wingfoot Lake east of Akron will be opened Jan. 23 for assemblage of a new dirigible for the United States Army which will embody transmission principles said to be entirely new to dirigible navigation.

Instead of having its motors perched upon the outriggers of the car in front of the propellers as is the method employed on all present dirigibles, the new army blimp will have its twin engines in the cockpit of the car. A new system of gear shifts and transmission invented by Herman Kraft, chief aeronautical engineer at Goodyear, makes possible this new engine arrangement. The new system has been tested and approved by the Government. It permits shifting of gears, throwing the propellers into reverse, operation of the propellers separately or the throwing of the power of both motors to either propeller.

Repairs Possible in Air

One of the advantages of the new system, according to Goodyear aeronautical experts, is the fact that it permits motor repair in mid-air without imperiling the members of the crew. The possible throwing of the propellers into reverse will greatly facilitate the landing of the big ship, it is stated.

Kraft's new transmission invention, it is stated, promises to revolutionize dirigible construction. It will also be applicable to heavier-than-air craft and will probably be used on all Government blimps and airplanes in the future. Aeronautical engineers have worked for years to accomplish that which Kraft and Government officials say will be achieved when the new army ship is completed.

The blimp will be 170 feet long and will have a gas capacity of 180,000 cubic feet. It will have a speed of 60 miles an hour, and a cruising radius at full speed of 14 hours, with a 20-hour cruising radius at reduced speed.

Another feature of the blimp will be the first all-enclosed car ever made for a non-rigid dirigible. The car embodies Pullman accommodations and sleeping quarters for its crew of seven, and will be equipped with wireless apparatus and all modern appliances.

GREGORY PLACES ORDERS

MOLINE, ILL., Jan. 14 — Gregory Front Drive Motor Co. has placed orders with the O. E. Szekely Co. for the five front-drive automobiles. The possible location of the plant here devoted to the manufacture of a car of that type is likely. The Gregory car, it is said, will sell for about $1,550. The company has a capitalization of $200,000.

MEN OF THE INDUSTRY

George W. Cushing, advertising manager of the Hudson Motor Car Co. and Essex Motors, was tendered a complimentary dinner in Detroit upon the occasion of his resigning that position to become affiliated with Barton, Durstine & Osborne, Inc., an advertising agency. Addresses were made by Roy D. Chapin, Hudson president, and C. C. Winningham, president of the Detroit Adcraft Club who was Cushing's predecessor with Hudson. He has been affiliated with the Hudson company since November 1916 and became advertising manager in January, 1920. He is active in all advertising movements and has been a director of the Audit Bureau of Circulation since 1919.

Henry Sheridan, foreign representative of the Avery Tractor Co., Peoria, Ill., has returned from a two-year trip around the world, surveying export conditions, establishing agencies and booking orders. **E. M. Brown has been appointed sales** manager of the company to succeed **C. E. Bronner** who has been made credit manager. The former has been with the company for seventeen years and the latter for twenty years. **A. Y. Bartholomew,** formely assistant sales manager, has been given the post of field manager.

Roland Gerry, a director of the Jones & Laughlin Steel Co. and manager of sales of the cold-rolled department, has been advanced to the position of special sales representative of the company for the United States and Canada. He will be succeeded in the cold-rolled department by **William B. Todd,** vice-president of the Union Drawn Steel Co., Beaver Falls, Pa.

Harry H. Anderson, formerly connected with the sales department of the Firestone Rubber Co. on the Pacific Coast and later associated with the California distributor of the Oakland, has been appointed assistant general sales manager of the Leach Biltwell Motor Car Co.

George W. Cole, for many years associated with O. J. Rohde, general manager of the Wire Wheel Corp. of America, returns to that organization as manager in charge of the New York Branch, Eleventh avenue at 57th Street.

R. B. Perry, for the last six years connected with the Allen Motor Co., has resigned as director of sales and service to become general sales manager for the Atlas Brass Foundry Co., also of Columbus.

H. G. Evans, for four years associated with Winther Motors, Inc., Kenosha, in various sales and service capacities has been appointed advertising manager for the company.

George B. Hendrick, who recently resigned his position as publicity manager for the Fisk Rubber Co., has been appointed sales manager for the company.

Roy D. Tyler, well known in industrial engineering circles, has become associated with the Standard Conveyor Co. of North St. Paul.

Albert S. Holly, formerly New England representative for the Pollack Tire Co., has been appointed sales manager of the Bridgeport Motor Truck Corp. of Bridgeport, Conn.

Harry Eisner has opened an automotive electric equipment station at 907 Boylston Street, Boston, Mass.

SUES FOR TIRE RECEIVER

McALESTER, OKLA., Jan. 16—Suit for appointment of a receiver for the Great Republic Tire & Rubber Co. and for an accounting looking to the recovery of money alleged to have been secured by the company on an issue of $100,000 in notes in October, 1919, has been filed in the District Court by H. A. Boyles of Muskogee, Okla. The defendant company owns a plant site and equipment north of this city. Boyles alleges that the company made an effort to transfer its property to the Prudential Tire & Rubber Co., and that this latter is a bankrupt.

American Bosch Perfects Selling Arrangements

SPRINGFIELD, MASS., Jan. 17—At a meeting of more than 50 sales managers and agents of the American Bosch Magneto Corp., representing all parts of the United States, the company's new selling arrangements were further perfected.

It is said the sales force will comprise more than 2000 members, the new policy being to have a large number of agency dealers in close relations with the factory. Engineering and production experts will be taken from the plant to assist in promoting sales. Factory branches will be maintained in New York, Chicago, Detroit and San Francisco.

In extending its line of motor accessories one of the main purposes, it was said, is to give increased efficiency to cars already in use.

Beall Heads Syndicate Making Crude Oil Tests

DETROIT, Jan. 18—The Barnsdall Corp. of New York is working under a license from a syndicate headed by Frank F. Beall, vice-president of the Gray Motors Corp., testing the commercial possibilities of a new motor fuel derived from crude oil. Beall says that although the chemical results have proved conclusively, the commercial possibilities have not been demonstrated and the results of further experiments will be awaited before an organization is formed by the syndicate now controlling it to market the product.

It is expected the experiments will be completed early in February. Under the formula used the oil is said to yield from 70 per cent to 80 per cent of the motor spirit and if it works out commercially the price will be considerably lower than that of gasoline.

Allan A. Ryan Resigns from Stutz Directorate

NEW YORK, Jan. 18—Allan A. Ryan, who sailed for Europe yesterday, resigned as a director and chairman of the board of directors of the Stutz Motor Car Co. before he left the city. He retains his stock interest in the Stutz company but it is in the hands of trustees and does not require his attention. Upon his return, Ryan expects to devote most of his time to the Frontenac Motor Co., of which he is chairman of the board.

Street Car Makers Are Building Buses

Expect Motor Vehicle Business to Equal Volume of Regular Lines

CLEVELAND, Jan. 16—The G. C. Kuhlman Car Co. and the Gustav Schaefer Wagon Co. have found the motor bus field surprisingly large and profitable. In fact the two companies, which are among the oldest and best established of the city, are looking forward to the time when the motor bus business will equal the volume of their regular lines.

The Kuhlman car works is a subsidiary of the J. G. Brill Co. of Philadelphia. It has for years been an extensive builder of street railway and interurban cars and is one of the largest producers of those products in the country. Two years ago it began the construction of motor buses, to meet a quickening demand. The Brill company also builds street cars in Philadelphia, but has been concentrating upon the building of motor buses in the plant in this city. The rate at which the motor bus business of the company has grown leads company officials to predict that within three years this class of work will occupy as much time as the building of street and interurban cars.

Standardizes Bus

Last week the company shipped four motor bus shells to its Preston, Ont., plant to be finished for the Toronto transportation commission, which will use them for extension purposes.

The Kuhlman Co., recently standardized its light bus after development work extending over two years. Within the last three months a new form of tapered front has been designed and patents applied for on a method of clamping the light wooden roof to the rim and fastening it to the sides. Except for the roof the body is of steel construction built upon the same principles as those used in constructing street cars. The same factory buildings and similar patterns are used.

Low Type of Chassis Used

Most of the buses built are on the new low type of chassis designed to keep the center of gravity far down in the machine and prevent upsetting. These have been on the market six months. An emergency door also is a helpful equipment. The central and far west have been the best markets for the buses, reports show.

The Gustav Schaefer Wagon Co. has eight motor buses under construction and during the year just ended built more of them than ever before, according to Ernest C. Schaefer. A light body is featured by this company. H. G. Schaefer of the company visited New York last week discussing plans with an electric railway company, which proposes to use buses for extension purposes.

5 Benz, 3 Mercedes For European Race

Italy, England and France to Enter Event Scheduled for September

PARIS, Jan. 7 (*By Mail*)—Five Benz and three Mercedes cars have been entered in the European Grand Prix automobile race to be held in northern Italy, either at Brescia or near Milan, next September. This race promises to be the most international speed contest in Europe this year, and is the only one in which German firms are admitted. It is believed that Opel will put in a full team. Among Allied firms practically certain starters are Fiat for Italy, Sunbeam for England, Rolland-Pilain and Bugatti for France.

Rumpler Patents Used

The Benz cars, which are already under construction, are being built under the patents of Dr. Rumpler, one of the leading German aviation experts. Rumpler, who has sold his license to Benz, places his engine at the rear of the chassis, drives to the rear wheels, and in addition to abolishing practically all unsprung weight obtains a perfect streamline form. Nothing projects from his bullet shaped car excepting two short lengths of axle at the front and rear. The road springs are inside, as well as all spare wheels and accessories.

For touring purposes Rumpler claims improved suspension, more comfort and room for the passengers and greater fuel economy. For racing, particularly under the 122-cubic inch rule he claims an immense advantage by reason of a scientific streamlining hitherto unknown in automobile practice. The racing cars have six cylinders in line, the center of the engine being just a little to the rear of the center of the chassis, while the drivers and mechanic are seated ahead of the engine with only just sufficient of the head projecting to give a view of the road. Height of the cars from the ground will not exceed 26 in. With this design it is possible to keep down to the minimum weight of 1430 pounds. Rumpler claims that the 2-litre racers will show a speed of 115 miles an hour.

Nineteen Cars Entered for French Grand Prix

PARIS, Jan. 7 (*By Mail*)—Nineteen cars, representing France, Italy and Great Britain, have been united for the French Grand Prix automobile race for 122 cubic inch machines to be held at Strasbourg on July 15. The French representatives are Rolland-Pilain 3, Delage 2, Bugatti 4, Mathis 1, and S.L.I.M.-Pilain 1. Italy is sending a team of three Fiats; England has entered three Sunbeams and two Aston-Martins.

On the day following the 122-cubic inch race and over the same course, there will be a fuel consumption speed test, in which sixteen French cars will start. The competitors comprise Voisin, Bignan and Peugeot with three each; Delage with three and Bugatti with two, and A.M. and S.L.I.M.-Pilain with one each. These cars must have four seater bodies, weigh 3086 pounds empty, and must run 13.7 miles to the gallon of gasoline. This allowance of fuel will comprise oil for the engine and oil or grease for the rear axle and transmission.

It is understood that Ralph de Palma has signed a contract to drive a Voisin in the fuel consumption Grand Prix.

FINANCIAL NOTES

Amazon Rubber Co. during the last six months of 1921 reduced its indebtedness by $70,000, the Dec. 31 statement showing an entire indebtedness to be less than $50,000 on notes and accounts payable. None of this is past due. The company has no bank loans. The company has started the new year with all its material bought at market prices and it is stated that on account of efficient factory methods and low sales and administration expense is able to show a good profit on its merchandise with the present low prices.

American-La France Fire Engine Co., Inc., shows total profits for eleven months ending Nov. 30 of $843,600; dividends, $370,400 and surplus, $185,900. Earnings for the year, it is stated at the factory, will equal about 18 per cent on the common stock. The company would close the year, it was also said, with $450,000 cash and $120,000 government securities.

Ajax Rubber Co. stockholders have approved the issuance of $3,000,000 first mortgage 15-year 8 per cent bonds and also a change in the present capital stock from 400,000 shares of $50 par value to 500 000 shares of no par value. A total of 169,861 shares were represented at the meeting, all of which were voted in favor of the change.

Wayne Oil Tank & Pump Co., Fort Wayne, Ind., declared a 20 per cent stock dividend on the outstanding common stock, a 12 per cent per annum dividend to be paid in monthly installments during 1922 and an extra cash dividend of 1 per cent to be paid Feb. 1. Reports made at its annual meeting indicated a highly prosperous year.

Nash Motors Co. declared a dividend of $10 a share on the common stock, payable Feb. 1 to stock of record Jan. 20. The regular quarterly dividend of $1.75 a share on the preferred stock was also declared, payable Feb. 1 to stock of record Jan. 20.

White Co. inventories during 1921 were reduced from $23,000,000 to $15,000,000. Further reductions are being made by keeping the output under the level of current sales. Bills payable were reduced from $7,200,000 to $3,600,000.

Wedgerste Piston Ring Co. of Plattsburg, N. Y., has filed a voluntary petition in bankruptcy with liabilities of $59,474 and assets of $14,049.

OBTAIN CONTROL OF NICE

PHILADELPHIA, Jan. 14—Control and ownership of the Nice Ball Bearing Co. by Budd G. Nice, the president, and members of his family, was obtained by the terms of a settlement entered into before the United States Circuit Court of Appeals in New York.

BANK CREDITS

Written exclusively for AUTOMOTIVE INDUSTRIES *by the Guaranty Trust Co., second largest bank in America.*

The easier tendency in the local money market which had developed in the previous week was still more pronounced during the past week. Call money ruled at the lowest figures since September, 1919, the week's range being from 3 per cent to 4 per cent as compared with 3½ per cent to 5½ per cent in the previous week. On Wednesday, Thursday and Friday of the past week, a flat rate of 3½ per cent prevailed. There was also a further decline in the quotations for fixed-date maturities, 4½ per cent being the prevailing rate for all maturities from 60 days to 6 months as compared with 4¾ per cent to 5 per cent in the previous week, while a few loans on Liberty Bonds were reported at 4¼ per cent.

Prime commercial paper rates remained unchanged at 4¾ per cent to 5 per cent. On Monday of this week the rate for call money jumped from 3½ per cent to 6 per cent.

The Federal Reserve statement of Jan. 11, 1922, showed a rise in the reserve ratio from 71.7 per cent to 74.7 per cent.

For the first time since September, and the second time since July, 1920, the unfilled orders on the books of the United States Steel Corp. on Dec. 31, 1921, showed an increase. The forward business as of that date was 4,268,414 tons, as compared with 4,250,542 tons at the close of November, and 8,148,122 tons on Dec. 31, 1920. The December increase of 17,872 tons was due mainly to reduced operation in the mills, which in December were running at about 45 per cent of capacity, as against slightly more than 50 per cent in November.

The production of pig iron in the United States for December was reported to be 1,649,086 tons, an increase of 233,605 tons over the amount reported for the previous month and just a little short of twice the amount reported for the month of July, 1921, when the bottom in the decline in the production of pig iron was reached. The total number of active furnaces on Jan. 1, 1922, was 125, or five more than at the beginning of December.

The preliminary foreign trade figures made public last week by the Department of Commerce showed a decline of $3,743,250 in exports, which, in conjunction with a $2,770,029 decline in imports, resulted in a favorable trade balance of $973,221,000 less than for 1920. In spite of this apparently unfavorable showing, our export trade for 1921, even after allowing for changes in price levels, was in excess of that for 1913.

PACKARD TO MAKE NEW TRUCK

DETROIT, Jan. 16.—The Packard Motor Car Co. expects to go into production some time this year on a ¾-ton truck which it has been designing and experimenting with for several years.

METAL MARKETS

Demand from automotive consumers is becoming more and more of a factor in the steel market from day to day, but steel producers are chafing under the self-imposed restraint of purchasing agents in the matter of tonnages involved in their orders. Steel sales managers naturally lean to the view that automotive consumers are making too many bites of one cherry and propaganda is being resorted to in an effort to bring about heavier commitments.

From Pittsburgh and Youngstown emanate inspired statements on this order: "A prediction made by a well informed (steel) maker is that in April the automobile factories will be crowding each other trying to get deliveries, not so much on account of their requirements being especially heavy as on account of their delaying purchases." The chief interest's sheet mills are operating at about two-thirds capacity and those of the "independents" at two-fifths. Thus the rate of operations for the entire sheet industry is about one-half of its capacity.

Far-sighted automotive purchasing agents are bearing this in mind; they are buying conservatively but consistently. In numerous negotiations preceding sheet transactions the Pittsburgh base has figured of late. Youngstown sheet rollers assert that orders for large tonnages on a mill basis have been declined and that consumers west of Pittsburgh have been obliged to place all orders on a straight Pittsburgh base, the actual freight differential accruing to sellers. Of the steel market in general, however, it may be said that the Pittsburgh base has largely fallen into innocuous desuetude, so much so in fact, that when this trade custom is again reviewed before the Federal Trade Commission it will have become an almost obsolete issue.

Pig Iron.—Michigan and Wisconsin automotive foundries have been taking on modest tonnages of both foundry and malleable iron with quite a few representative inquiries still overhanging the market. If changed at all, however, the market's tone is a shade weaker and this in spite of continuing protests on the part of blast furnace operators that they are losing money on every ton of iron sold at present prices.

Steel.—It is difficult to reconcile the utter lethargy which prevails in the sheet bar market with the brisk demand that characterizes that for full-finished sheets. It is the rollers of the latter who are one of the mainstays of the sheet bar market. One of the large producers of full-finished sheets in the Mahoning valley claims to have his entire capacity booked until the middle of next month. The leading manufacturer of low-priced passenger motor cars is reported to have concluded placing of orders for between 10,000 and 12,000 tons of sheets at prices very close to the quoted market.

Aluminum.—The aluminum market appears to have turned the corner. Sellers of imported virgin ingots, 98 to 99 per cent pure, are asking 17½ cents as inside price.

Copper.—Prospects of additional producers resuming mining and smelting in the spring are imparting an undertone of weakness to the market which still has much surplus metal to digest.

HEARING ON FREIGHT CAR LOADS

NEW YORK, Jan. 18—The traffic department of the National Automobile Chamber of Commerce has been informed that it will be given a hearing in Chicago on Feb. 1 by the Transcontinental Freight Bureau on a proposal to increase the minimum loadings of freight cars carrying passenger cars and trucks to California. The railroads now contemplate raising the present special minimum to the regulation classification minimum. If this is done it will considerably increase the cost of transporting motor vehicles to the Pacific Coast.

Continental Shows Loss of $371,534 During Year

DETROIT, Jan. 18—In the fiscal year ended Oct. 31, 1921, the net loss of the Continental Motors Co. was $371,534, compared with a profit for 1920 of $3,567,504. In addition the company took a $904,293 inventory loss in 1921. The balance sheet surplus, as of Oct. 31, 1921, of $4,779,066, and at the end of the previous fiscal year, $6,345,309.

After readjustments made during the year, value of orders on the books on the October date, was $38,568,686, or 28 per cent less than at the close of previous year. Contracts during the past two months, however, bring the total to over $50,000,000.

Substantial manufacturing schedules, especially of truck motors, are being released, and shipping schedules for the first two months of the current calendar year are considerably in excess of any two months of the past fiscal year.

Cobleigh Makes Address at Service Convention

NEW YORK, Jan. 14—The third annual convention of Service Associations was held here yesterday with less than a score of delegates. It has been the custom to hold this convention during show week because a number of service executives from all parts of the country are in the city. Due to curtailment of expenses this year, however, not many service men have been away from their factories, and it was not expected that the meeting would amount to more than a get-together dinner.

H. R. Cobleigh, service secretary of the N. A. C. C., spoke at length on the work the chamber had done in promoting local associations and gave a list of seventeen now in existence, and reported several others in the process of formation. Representatives from Brooklyn, Newark and New York comprised the bulk of the delegates.

Paige Opens Warehouse

ATLANTA, Jan. 13—A wholesale factory warehouse has been established in this city by the Paige Detroit Motor Car Co., with B. J. Rector in charge as manager. A complete stock of motor cars and parts will be carried for the southeastern territory. Edward A. Thilenius, district manager, and W. R. Morse, representative in Georgia, will maintain their headquarters at Atlanta.

INDUSTRIAL NOTES

Kelly-Springfield Tire Co. is turning out approximately 4,500 tires daily, against 3,500 a day last summer. A night shift is being operated at the Cumberland, Md., plant where it is purposed to concentrate all the company's activities. To this end the Buffalo plant has been completely shut down and the Wooster, Ohio, factory is about to stop operations. These latter plants subsequently will be disposed of. The company has worked off its high priced raw materials and has been purchasing crude rubber and cotton fabric at market prices for some months. No effort is being made to contract ahead for any large supplies.

Association of Automotive Equipment Manufacturers, Chicago, has re-elected Nathaniel Leverone as president and W. E. Green as secretary. Although a large percentage of the present members of the association are located in Chicago, Milwaukee and vicinity, the scope of the organization is national in character. It includes in its membership manufacturers of automobile accessories, parts and equipment.

Jacques Manufacturing Co., Philadelphia, manufacturer of automobile bodies, has moved into its new factory building in that city, which affords greater facilities to care for 1922 business. The company has specialized in closed cars on a production basis, the output during the past year going into the product of four of the makers of cars in the $3,000 to $5,000 class.

Harley Co., recently reorganized with Albert W. Morris as president, announces that negotiations are under way that are expected to bring $6,000,000 in contracts to the company. It is understood these will come from a single concern. Operations have been started at the plant with a small force with a view to adding men as rapidly as conditions permit.

Fisk Rubber Co. has resumed operations at both its own plants at Chicopee Falls and Federal Rubber plant at Cudahy, Wis., on a schedule in excess of that at any time during 1921. As of Jan. 14 the company was turning out 9,000 casings daily while Federal was producting 3,000, or an average of 70 per cent capacity against 50 per cent in November, 1921.

Wall Pump & Compressor Co., Quincy, Ill., has added to its line of vacuum pumps a complete line of air cooled single stage compressors and a line of air cooled two stage compressors. Included are approximately thirty different combinations suitable for all automatic requirements. C. A. Dickerson is in charge of sales.

Brandenburg Bros. & Eccleston of Chicago, Detroit and New York, selected as sales agents for the gear shift division of the Cutler-Hammer Mfg. Co., Milwaukee, will also market the latter's new small mechanical gear shift.

Metal Specialties Manufacturing Co., Chicago, has added the Jorgensen vapor primer to its line. The primer was formerly manufactured by the Jorgensen Manufacturing Co., Waupaca, Wis.

Parish & Bingham plant at Cleveland has resumed operations after the usual shut down at the end of the year. The principal operations are on Ford orders.

Hoover Body Co. has opened an Eastern sales branch at Long Island City with William M. Miller in charge.

Calendar

SHOWS

Jan. 28-Feb. 4—Chicago, Automobile Salon, Hotel Drake.

Jan. 28-Feb. 4 — Chicago, National Automobile Show, Coliseum, Auspices of N.A.C.C.

Feb. 6 to 11 — Seventh National Tractor Show and Educational Exposition, Minnesota State Fair Grounds, Minneapolis.

Feb. 6 to 11 — Winnipeg, Can., Automotive Equipment Show, Western Canadian Automotive Association.

FOREIGN SHOWS

March, 1922 — Santiago, Chili, Annual Automobile Show.

April 16—Mexico City, Annual Automobile Show, Auspices of the Automotive Division of the American Chamber of Commerce.

April 22-May 1—Prague, Czecho-Slovakia, Fourteenth International Automobile Exhibit.

May, 1922—Quito, Ecuador, Agricultural Exposition, celebrating Centenary of Ecuador. Automotive Section.

Sept. 1922 — Rio de Janeiro, Brazil, Automobile exhibits in connection with the Brazilian Centenary Associcao Automobilista Brazileria.

CONVENTIONS

Jan. 17-20, 1922—Chicago, American Road Builders Association.

Jan. 30-31—Chicago, Fifth Annual Convention, N. A. D. A., La Salle Hotel.

Jan. 30-Feb. 2—Boston, Sixth Annual Conference of the International Delivery Association, Copley Plaza Hotel.

May 10-12—Philadelphia, Ninth National Foreign Trade Convention of the National Foreign Trade Council.

June 11-15—Milwaukee, Annual International Convention of the Associated Advertising Clubs of the World.

June 26-July 1—Atlantic City, Twenty-fifth Annual Meeting of the American Society for Testing Materials, Chalfonte-Haddon Hall Hotel.

Sept. 18-23, 1922—Rome, Italy, Second Annual Meeting of the International Chamber of Commerce.

S. A. E. MEETINGS

Detroit, Feb. 24, Mar. 24, April 28, May 26.

Chicago, Feb. 1

Minneapolis, Feb. 8-9—Annual Tractor Meeting.

Industrial Films Elicit Some Interest

Association of Manufacturers Plans Moving Pictures Showing Methods at Factories

WASHINGTON, Jan. 14—Several automobile manufacturers are interested in a plan of the National Association of Manufacturers to have industrial motion pictures made showing production and distribution methods now employed in many industries. The motion pictures would be of an educational nature under the auspices of the Department of Commerce.

The Chevrolet Motor Co. advises the association that the suggestion in regard to consolidation of distribution for industrial pictures is under consideration and undoubtedly would be favorable to manufacturers, provided it was adequately handled. The Cole Motor Car Co. asked for further details. The Firestone Tire & Rubber Co. and the Kelly-Springfield Tire Co. also ask for additional details.

Former Cleveland Mold Company Officials Sued

CLEVELAND, Jan. 16—Several suits have been started by William A. Ahelton, vice-president of the Cleveland Rubber Mold & Machine Co., for the recovery of $248,612.16 in connection with the promotion and management of the company, which was organized to manufacture and sell rubber products.

In two of the petitions it is charged that the Davis Co. and the Fairwin Co. were formed to sell stock in the Cleveland company and that the organizers collected commissions amounting to $191,-112.16. The defendants include I. R. Davis, former president; George H. Burrows, former vice-president; A. S. Davis, former treasurer; C. B. Hurd, former assistant secretary; George S. Winner, F. J. Fairchild and three unnamed persons.

Other suits ask that the former officials be enjoined from selling capital stock now held in escrow by the State Securities Department.

447,675 Carloads Produced in First 9 Months of 1921

NEW YORK, Jan. 16.—A compilation made by the traffic department of the National Automobile Chamber of Commerce of Interstate Commerce Commission statistics for 1920 shows a total of 447,675 carloads of passenger cars, truck chassis and parts, not including tires, shipped in that year and a total of 273-845 carloads shipped in the first nine months of 1921.

Carload shipments of passenger cars and trucks in 1921 totalled 195,153 as compared with 251,064 in 1920. Driveaways in 1921 were 144,377 as compared with 470,867 in 1920. Machines shipped by boat in 1921 numbered 22,244 and 32,-833 in 1920.

NAMED FOR FARM MEETING

WASHINGTON, Jan. 18—Representatives of the automotive industry have been assigned to two important committees of the Agricultural Conference which will convene here next week. Windsor T. White will serve on the railroad committee while Roy C. Chapin and H. S. Firestone will be members of the highway committee. These three spokesmen for the industry will act in an advisory capacity and will have much to do with shaping the conference program.

EXHIBITING AT BROOKLYN

NEW YORK, Jan. 18 — Seventeen manufacturers of automotive products are among the exhibitors at the Brooklyn Industrial Exposition, being held this week to show the output of Brooklyn factories of all kinds. The automotive manufacturers represented are: Advance Rubber Co., Mohegan Co., Marko Storage Battery Co., Robert Gain Co., C. Kenyon Co., C. J. Taghabue Mfg. Co., Sperry Gyroscope Co., Electrose Mfg. Co., Westinghouse Lamp Co., Peelle Co., E. W. Bliss Co., J. H. Williams & Co., American Machine & Foundry Co., Adriance Machine Works, Inc., Doehler Die Casting Co., Batley Corp., A. Schrader's Son, Inc.

Good Motor Market Is Found in Hawaii

Johnson of Honolulu, Rickenbacker Agent, Thinks Field Neglected

BOSTON, Jan. 18—"If the motor business in Hawaii can jump more than 100 per cent from 1919 to 1920 and then climb again some 30 per cent more in ten months during 1921, there is nothing the matter with our place, from a selling standpoint," according to J. A. M. Johnson of Honolulu. He came over to this country to look over new lines, and stopping in Detroit he decided to take the agency for the Rickenbacker car.

"In 1919 our islands did a business in cars, trucks and accessories of $1,344,-149. We thought it was pretty good until the 1920 figures were made known showing that they had been run up to $3,257,791. And up to Nov. 1 of last year the business was $4,696,325. And we have not got started yet. For example, some men handle a dozen lines of cars and, of course, there is no chance to specialize on sales or service. But we are learning. In a few years the manufacturers will pay a little more attention to our territory."

ASKS INLAND RECEIVER

INDIANAPOLIS, Jan. 16—Receivership suit has been filed against the Inland Automobile Co. of this city, manufacturer of convertible delivery bodies for Fords, which began business early last year.

C. C. Knudsen, president, lists the asests at about $90,000 and the total amount of unpaid bills at $1,350. He claims the company is entirely solvent.

K-W IGNITION LOSES

WASHINGTON, Jan. 17—A petition for a rehearing of the case of the K-W Ignition Co. against the Ford Motor Co. for infringement of a patent on ignition coil used on automobiles was denied by the Supreme Court. This gives a victory to the Ford company, involving several million dollars.